It is with great pleasure that Pollution Probe brings you this primer on drinking water. The current high level of public interest and concern about drinking water safety and quality make this a timely publication.

In 1998, Pollution Probe made a commitment to build a comprehensive water programme, starting with a renewed emphasis on drinking water. We had not prepared a formal study on drinking water since the early 1980s, at which time we advocated the development of a Safe Drinking Water Act for Ontario. This didn’t occur, but the safety and quality of drinking water has always been of interest to Pollution Probe. In early 1998, we started planning for a major conference on drinking water. The conference was held November 16-17, 1998 in Toronto, and resulted in the publication in 1999 of a major report, The Water We Drink: Examining the Quality of Ontario’s Drinking Water.

This report is available at www.pollutionprobe.org/Publications/Water.htm

Following the conference, Pollution Probe framed a three-point water program based on the following: Source Protection, Consumer Confidence Reporting and Full-Cost Pricing. While this programme was being developed, the Walkerton, Ontario, tragedy hit in May 2000. This tragedy, and the subsequent Inquiry led by Justice Dennis O’Connor, sent shock waves across Canada. Public concern about the safety and quality of drinking water rose rapidly and governments began to investigate the state of drinking water systems. It soon became clear that a number of problems existed, particularly with respect to smaller drinking water systems, but also in terms of the funding required to maintain even the larger systems. The Walkerton Inquiry has produced a wealth of new information on the state of Ontario’s drinking water, and Part I of the Inquiry’s report, which was released in January 2002, was a milestone in the history of drinking water in Ontario, as was Part II, which was released in May 2002.

To foster improved understanding on the vital subject of ensuring clean and safe water, Pollution Probe is pleased to offer this Drinking Water Primer to the public. We welcome feedback on the primer and encourage you to pass it to others interested in understanding the issues involved in maintaining safe drinking water.

Richard Findlay
Water Programme Director
Pollution Probe
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Prepared for Pollution Probe by RANDEE HOLMES.

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Prepared for Pollution Probe by RANDEE HOLMES.
You’ve probably seen pictures of the Earth taken from way out in space. You know, the ones where our planet looks like a big ball of blue topped with wispy swirls of white clouds. It really is quite beautiful. But do you know why the planet looks so blue when viewed from far, far away? Simple. It’s because more than 70% of the Earth’s surface is covered by water. In fact, it is water that makes all of life possible on the planet, from the tiniest bacteria to the tallest tree. Nothing on this planet, including human beings, can survive very long without water.

You might think that with all this water on the Earth, it wouldn’t ever be a problem to find enough. There ought to be plenty to go around for everyone. But unfortunately that isn’t the case. In fact, finding sources of water that are both fresh and clean is very difficult. That’s because most of the water on Earth, 97% of it, is salt water and not suitable for drinking. Of the fresh water on Earth that would be fit for drinking, about two-thirds of it is frozen in glaciers and ice caps. The part that is left is less than 1% of all water on Earth. This is the water we find in the atmosphere that falls as rain and snow; in fresh water bodies such as lakes, rivers and streams; in wetlands; and in the ground. This small percentage of fresh water is what all of us, all over the world, rely on for our drinking water.
What is Water?

You’ve probably heard water referred to as H₂O. Do you know why it’s sometimes called that? It’s because water is made up of three atoms — two hydrogen atoms (H₂) and one oxygen atom (O₂).

On Earth water is found in three different forms: as a liquid, as a solid (ice), or as a gas (water vapour). Water in its liquid form is what we bathe and swim in and also what we drink. When water is in its solid form we skate on it and put it in our drinks to keep them cold. In its gaseous state water forms a kind of blanket around the Earth. The sun warms the surface of the Earth, and the water vapour absorbs the heat and holds it to keep the Earth warm.

Water as an Ecosystem

An ecosystem is an ecological community together with its environment that functions as a unit. Members of the community depend on each other and their environment for food and shelter. In an aquatic, or water, ecosystem this includes very small organisms such as bacteria, fungi, and protozoans; organisms that live on the bottom of a water body, such as insect larvae, snails and worms; free-floating microscopic plants called plankton; large plants such as reeds, grasses and bulrushes; and animals such as fish, amphibians, reptiles and birds. Freshwater ecosystems in Canada include lakes, ponds, rivers, streams, prairie potholes and wetlands.

Human beings rely on aquatic ecosystems for many things. Some of our uses for water include drinking, bathing, growing food, cooking, transportation and recreation. The water that humans rely on for all their needs is the same water that other plants and animals use to meet their own needs. Some species use the water to drink, for others it is a source of food, and for others water is their home where they live and grow. This is one of the reasons why it is important for people to take great care with the water they use. Whatever we do to water may affect the lives of hundreds of thousands of other species. Because everything is connected, eventually it will affect us too. Humans are also part of the ecosystem.

The Ultimate Recycling System

Did you know that there is just about the same amount of water on the Earth now as there was when the Earth was formed more than four and a half billion years ago? The same water molecules have been moving about the Earth for all those years. That means that you could be drinking the same water molecules as the dinosaurs once did. Imagine that!

The endless circulation of water from the atmosphere to the Earth and back to the atmosphere is called the hydrologic cycle. At any given time, about 5 litres of every 100,000 are in motion. There are three basic steps to the hydrologic cycle: evaporation and transpiration; condensation; and precipitation (see opposite page).
A Global Perspective

On a global scale there are increasing problems related to the availability of drinking water from freshwater sources. We know that we have less than 1% of all water on Earth available to us to use as drinking water. And we know that over the history of the Earth this amount has never really changed very much. What has changed, though, is the number of people on Earth and the amount of demand we all place on the freshwater supply. Even though we now have the same amount of water as we have always had, we are using a whole lot more of it. Just within the past 50 years the amount of water we use around the world has tripled.

With so many more people using so much more water it means that there isn’t always enough to go around. It is predicted that by 2025 many countries will have only one-quarter the amount of water they need to be productive and efficient as nations. According to the United Nations Environment Program (UNEP) close to one-quarter of the world’s population may soon suffer from chronic water shortages.

Even if there is enough water for everyone, it may not be clean or safe enough to drink. Over the past twenty years many improvements have been made to provide increasing numbers of people with access to safe water. In the mid-1970s only 38% of people in non-industrialized countries had access to safe water. By 1994 this had increased to 75%. While this may be considered tremendous progress, that still leaves 25%—more than 1 billion people—without access to safe sources of water. In addition, almost half the world’s entire population—about 2.4 billion people—does not have an acceptable means of sanitation.

One of the results of poor sanitation and unsafe water supply is diarrheal disease. Infants, young children, and the elderly are most at risk. The World Health Organization reports that there are four billion cases of diarrhea in the world every year. Of these, 2.2 million people die as a result, and most are children under five years of age. Diarrheal disease accounts for more deaths each year than AIDS and cancer combined. With a safe water supply and adequate sanitation and hygiene, the number of cases of diarrhea could be reduced by one-quarter to one-third.
In Canada, many First Nations people live close to the land. This is particularly the case for those living in rural and remote communities, versus those who reside within more urban municipal areas. Since they directly rely on the land to obtain their food and water, it is very important that their water supplies be clean and safe. But, unfortunately, in many cases they aren’t. In fact, First Nations people live in some of the worst conditions in Canada. According to a 1995 federal government report, approximately 25% of the water systems in First Nations communities pose a danger to people’s health and safety, or do not meet basic government standards.

Given that we have and use so much of it, Ontario has for many years invested in providing its residents with clean supplies of water. Indeed, in the past, Ontario was viewed as a world leader in providing treated drinking water to its citizens. As early as 1962, almost all of Ontario’s urban communities (98%) were serviced by modern drinking water treatment facilities. For 66% of Ontario residents, their drinking water originates in the Great Lakes. The water in these lakes is generally of good quality and therefore easy to treat.

Water in Canada

Canada is home to a large portion of the Earth’s fresh water supply — about 15% of it is found here. Of all the fresh water that ends up in the world’s oceans, 9% of it comes from Canada. In fact, fresh water lakes and rivers cover nearly 8% of the whole country. The problem is that a lot of this water is far away from the places where most people live.

Approximately 60% of Canada’s fresh water drains to the north, while 90% of Canadians live in the southern part of Canada, within 300 kilometres of the Canada-United States border. Many areas of Canada have limited supplies of water. Even in the Great Lakes basin, the largest fresh water lake system in the world, there are some areas that experience periodic and even chronic water shortages.

And people need the water to be where they are, or at least to be brought close to them. Of the water that is accessible, much of it is contaminated because so many people use it and don’t take proper care of it.

Canada has been described as one of the most water-rich nations in the world. In absolute terms, we have as much water as each of China, Indonesia, and the United States. When the amount of water is measured per person, however, we have considerably more than these other countries.

Water in Ontario

Ontario also has abundant supplies of water. Lakes, 227 thousand of them, to be exact, cover more than 20% of the province.

Since we have so much water available to us, and because we pay so little for it, we end up using a lot of it. Every single day Ontario residents withdraw 1.25 trillion litres of water from surface water and groundwater sources. Can you imagine that much water? That’s twice the amount of water that flows out of Lake Ontario in a whole year. And it seems that our trend of using more and more water is expected to continue. It has been predicted that water use in Ontario will increase by at least 2.5% every year. That’s 50% faster than the rate of population growth and faster than the rate at which water can be replenished naturally.
Chapter Two:

Sources of Drinking Water

Depending on where you live in Canada, your tap water comes from either groundwater or surface water supplies. Groundwater is water that is found in soil or in cracks in underground rock. It is called groundwater because this water is in the ground, below the surface of the Earth. Surface water is water that is at the surface of the Earth. Surface water includes lakes, streams, rivers, ponds and dugouts.
When we want to take the water from underground to use in our homes and workplaces we use pumps to draw it to the surface. The water we take out is replaced with new water, often in springtime, from rainfall, melting snow and mountain streams. We have to be careful, though, not to take out too much. If we pump too much water out of an aquifer, the spaces between the soil particles and the rocks begin to compress. Without the water to keep the spaces open, the weight of the soil and rock causes the ground to close in and the spaces are lost.

When this happens, even if we never take water from the aquifer again, the aquifer would not go back to the way it was originally. It would have lost the capacity to store the same amount of water as it did before. We must be careful about the amount of water we take out of an aquifer because it is an ongoing source of water for many people. Over all of Canada, one in four people depend on groundwater to meet their daily water needs. That adds up to about eight million people. Some areas of the country rely on groundwater much more than others. For example, in Prince Edward Island 100% of the population relies on groundwater. In New Brunswick and the Yukon Territory more than 60% of residents depend on groundwater supplies to meet their needs. Most of the people in Canada who rely on groundwater live in rural areas and draw their water from private wells on their own property.

In its natural state, groundwater is usually quite clean and safe to drink. Water that seeps into the ground and through cracks in rock is naturally filtered by sand, soil and clay. This natural filtration process removes many microorganisms and some of the chemical contaminants that are present as a result of runoff from the land. Such filtration leaves the water cleaner than surface water. However, when groundwater becomes polluted it is very difficult to make it clean again. The simple reason is that we just can’t get to the water in order to remove the pollutants. It is important then to ensure that groundwater is kept clean.

It is also important to protect groundwater from becoming contaminated because it is linked to supplies of surface water. Since water is constantly moving, some groundwater will eventually make its way to the surface. It flows into streams, rivers, marshes, lakes and oceans or it may resurface as a spring. Groundwater is the only thing that keeps many streams flowing during dry weather periods of the year. And the amount of groundwater influences the amount of water that ends up in surface water bodies. When the ground has absorbed all the water that it can, during a rainstorm for example, the remainder runs across the land and empties into lakes and rivers. If a groundwater source becomes contaminated, those same pollutants will be carried into surface water supplies.

The amount of time that water stays under the Earth’s surface varies greatly. Some groundwater stays underground for only a few days or a few weeks. But some water may remain under the surface as groundwater for 10,000 years or more. In comparison, the water in a river is completely replaced with new water in about two weeks’ time.
Surface Water

For the majority of Canadians their drinking water comes from surface water sources. This means that it comes from water that is on the surface of the Earth in lakes and rivers. When snow and ice melt they feed into the lakes and rivers.

In addition to drinking water, lakes, rivers, and streams provide people with boating, swimming, fishing, and other forms of recreation. Surface waters are also used for agricultural irrigation, as process and cooling waters in power plants, and in many industries including chemical, steel, lumber, and mining operations.

Figure 3:
Percentage of Population Reliant on Groundwater

Municipal, domestic and rural only

Chapter Three:

Contamination of Water Sources

Having clean drinking water is very important to keeping us healthy. If we drink water that is not clean, there is a very good chance that we will become sick. There is even a possibility that we could die if we drink water that is contaminated. Contaminated water can also seriously affect the health and well being of many other living creatures.

It is important to understand what constitutes good quality, clean water. In nature, pure water does not exist. That is, it isn’t possible to find anywhere water that has absolutely nothing in it. Water is always found in combination with minerals and chemicals of one kind or another. Sometimes the compounds are naturally present and sometimes they are there as a result of human activity. Some compounds don’t appear to pose any health risk to humans, while others may pose mild to serious health risks. Some people, such as those with compromised immune systems, children and the elderly, may be more sensitive to particular compounds than others.
Because it goes through a natural filtration process, groundwater is less likely to be contaminated with harmful microorganisms than is surface water. Some contaminants such as arsenic and nitrate are, however, more likely to be found in groundwater than in surface water.

As well, surface water is more susceptible than groundwater to contamination as a result of human activity. Because it is more susceptible to bacterial and human-made contamination, surface water is typically treated at a facility before it is distributed to people in their homes and workplaces. As a rule, surface water should not be consumed without treatment. Groundwater that is at risk of contamination from surface water should be treated as if it were a surface water source.

In Canada, water may become contaminated from natural sources such as soil and rock. Natural contaminants that have the potential to cause harm include metals, such as arsenic and lead; radioactive compounds, such as radium and tritium; and microorganisms, such as bacteria, protozoa and toxic blue-green algae.

Water may also become contaminated from human sources. Human sources include garbage that is dumped into the water; chemicals that wash off lawns, roads, farms, parks and landfills and run into lakes and rivers; fuels that leak out of underground storage tanks; and pollutants we put into the air that fall to the ground and into the water. Water treatment plants themselves can introduce substances into water.

We may be exposed to these contaminants in our water in a number of ways. We may take a chemical into our body when we drink the water directly. We can also absorb contaminants through our skin, such as when we take a bath or shower or when we engage in recreational pursuits such as swimming or windsurfing. For example, according to Pollution Probe’s report, The Water We Drink (1999), studies have shown that inhalation exposure to chloroform and other THMs during showers might be comparable to the exposure of ingesting 1 to 6 litres of drinking water a day; skin absorption during a shower may be of a similar dose. We may also inhale chemicals in airborne water droplets or eat food that has been contaminated with water pollutants.

Although there are occasional exceptions, the overall quality of drinking water in Canada is very high. Research has shown that even when chemicals have been found in tests of municipal tap water in Canada, they are usually present at levels well below what is considered to be safe. For public treatment systems, the most potentially serious contamination problems in Canada usually involve inadequately treated surface water or groundwater.

Types of Drinking Water Contamination

There are five main types of water contamination: physical, microbiological, inorganic, organic and radioactive.

Physical Contamination

Turbidity, or cloudiness, in water is caused by the presence of suspended particle matter such as clay, silt or microscopic organisms. Turbidity is a common problem with water as a result of soil run-off. Surface waters, therefore, are much more likely than groundwater sources to be subject to chronic or occasional problems with turbidity.

Cloudy or turbid water is a problem because the particles in the water can serve as a source of nutrients and food for any bacteria, viruses or protozoa that may be in the water. In addition, because these microorganisms attach themselves to the particles in the water, and may be obscured by them, it can be difficult to determine exactly what substances are in the water. Cloudy water can also interfere with the ability of disinfectants to eliminate pathogens in the water both before and after they enter water treatment and distribution systems.

Microbiological Contamination

There may be organisms living in the water that are so small you can only see them with a powerful microscope. Some of these organisms don’t cause any harm if humans ingest them. Others, however, can cause us to become quite sick. In Canada, diseases caused by these microorganisms are the most common health hazards associated with drinking water.

It is hard to tell how many cases there are of waterborne diseases in Canada each year. Since the symptoms are often mild and similar to the flu, most people don’t go to the doctor for treatment. They may not even know that the reason they are sick is because of the water they drank.

Human and animal wastes are the main sources of microorganisms, or microbial contaminants that can cause disease in water supplies. Improperly treated sewage, bird droppings, and runoff from farms and city streets can all introduce microorganisms into the water. Of course, these organisms should be eliminated once the water is properly treated at a facility. First Nations communities and rural Canadians are most at risk of exposure to microbial contaminants because they frequently depend on private well water (groundwater), which is generally untreated.

Bacteria. While bacteria are present virtually everywhere, certain types which exist in untreated water may be pathogenic (capable of causing disease in other organisms). These bacteria can cause a variety of diseases. Infants, children, the elderly and people with weakened immune systems are most at risk of becoming ill due to ingestion of bacteria-contaminated water. The actual number of people who suffer from water-related illnesses is unknown.

Campylobacter. In terms of health effects, the species of this bacterium of most concern is Campylobacter jejuni, which causes gastroenteritis (inflammation of the stomach and intestines). This bacterium is typically found in human and animal wastes, including bird droppings, and often ends up in water after a heavy rainfall.

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Although there are occasional exceptions, the overall quality of drinking water in Canada is very high. Research has shown that even when chemicals have been found in tests of municipal tap water in Canada, they are usually present at levels well below what is considered to be safe. For public treatment systems, the most potentially serious contamination problems in Canada usually involve inadequately treated surface water or groundwater.
Metals may be naturally present in water, from weathering and erosion. The most common protozoa found in water are Cryptosporidium and Giardia. Almost all of the 2,000 strains of Salmonella that have been identified can cause illness to varying degrees. The species typically found in Canada are linked to gastrointestinal illness. The effects of Cryptosporidium contamination range from mild, flu-like symptoms to severe infections lasting for months, and potentially ending in death. Shigella. In the early 1970s, the most common cause of water-borne disease in North America was the presence of Shigella. However, in Canada, there hasn’t been a reported outbreak of illness due to this bacterium since 1975. Shigella can cause symptoms ranging from mild (diarrhea, vomiting) to severe (abdominal pain, fever, bloody stools).

Protozoa. Protozoa are organisms that have only one cell. Some of them are very strong and, once they enter our bodies, can be very hard to get rid of. While many bacteria in water are quite easily killed when chlorinated, a water treatment plant, protozoa can survive and must be removed by proper coagulation and filtration.

Giardia. In Canada, Giardia is the most common protozoan found in water. It causes a gastrointestinal disease known as giardiasis or “beaver fever,” which can last for a long time. Symptoms of Giardia infection may include watery diarrhea, loss of appetite, dehydration, cramps and vomiting. Wilderness campers and others who drink untreated water are most susceptible to Giardia exposure.

Cryptosporidium. Another common protozoan, Cryptosporidium is very resistant to chlorination, but can be killed by boiling water. In humans it causes cryptosporidiosis, a disease with symptoms that may include diarrhea, stomach cramps and a mild fever. These symptoms typically appear two to ten days after exposure. For people with a weakened immune system, such as people having AIDS, cryptosporidiosis can be fatal.

Viruses. Viruses are tiny organisms that invade the living cells of our bodies, reproduce and invade more cells, and soon make us sick. Viruses are responsible for the colds and flu we typically catch in the winter. More serious viruses, in water include the hepatitis A virus and several viruses that cause gastrointestinal disease. Some viruses may be killed with chlorination. Others, if they adhere to larger particles in the water, may be removed with small pore membrane filters, though this is not technically feasible for treating large volumes of water.

Giardia and Cryptosporidium in Canada’s drinking water

Between 1991 and 1995, Health Canada surveyed untreated and treated drinking water in 72 municipalities across Canada. Out of the 1173 samples of untreated water that they tested, 21% were contaminated with Giardia and 5% with Cryptosporidium. Out of the 423 treated water samples, 18% showed the presence of Giardia and 4% contained Cryptosporidium. In municipalities that had water filtration facilities, contamination was less common. Health Canada also reported, however, that only a small fraction of the parasites appeared to be viable and their ability to infect humans was not determined. They also stated that, nevertheless, outbreaks of illness linked to these parasites in drinking water had been reported in several provinces. Effective methods for determining whether and to what extent protozoa are present in water have not yet been devised. It is best, therefore, to assume that they are present in the water and to treat the water accordingly.

Escherichia coli. This bacterium is naturally present in our intestines and plays an important role in digestion. However, some forms of E. coli can cause gastrointestinal diseases, including a severe form of diarrhea that can lead to kidney failure and death. One way that E. coli ends up in water is from untreated sewage.

Salmonella. Almost all of the 2,000 strains of Salmonella that have been identified can cause illness to varying degrees. The species typically found in Canada are linked to gastrointestinal illness. The effects of Salmonella contamination range from mild, flu-like symptoms to severe infections lasting for months, and potentially ending in death.

Shigella. In the early 1970s, the most common cause of water-borne disease in North America was the presence of Shigella. However, in Canada, there hasn’t been a reported outbreak of illness due to this bacterium since 1975. Shigella can cause symptoms ranging from mild (diarrhea, vomiting) to severe (abdominal pain, fever, bloody stools).

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Phytoplankton. Phytoplankton are microscopic plants that live in saltwater and freshwater bodies. If there are a lot of these plants, they may make the water look green and murky. Some phytoplankton naturally produce toxins that can damage the liver or nervous system. This may pose a danger when very large numbers of these organisms are present, as may occur in small nutrient-rich lakes, ponds and ditches. Symptoms of exposure include fever, headache, dizziness, stomach cramps, vomiting, diarrhea, skin and eye irritations, sore throat and swollen lips. People are at greatest risk of exposure to toxic phytoplankton during blooms (quick and abundant growth of plankton in one area), which typically occur in late August and September. While it is unlikely that anyone would purposely drink the green, foul-smelling water from a lake or river during a bloom, people may accidentally ingest it during recreational activities such as swimming, canoeing or water-skiing.

Inorganic Contamination

Inorganic, or non-living, water contaminants include various metals, fluoride and nitrates.

 Metals. Metals may be naturally present in water, from weathering and erosion, for example, or they may be present as a result of human activities, such as mining and manufacturing. In most areas of Canada, drinking water is a minor source of exposure to metals as compared with food and air.

Arsenic. Arsenic may enter water bodies from smelting operations, the burning of coal and waste, and dumping of industrial waste water. It may be in particles in the air, which then land in the water. It may also be present as a result of natural processes, such as weathering and erosion.

Microbiological contamination of public water supplies is rare due to the requirements for disinfection and frequent monitoring of water both when it comes into the system and after it has been treated. If contamination occurs, the local public health officer will issue a boil water advisory, which will remain in effect until remedial measures have been taken and are effective. If the water you drink comes from a well, have the water tested at least once a year for microbial contamination. If your water is contaminated, it will have to be treated and then resampled before you can safely drink it. Contact Health Canada or your local public health unit for information on water purification methods.

If you go to a cottage or on camping trips, never drink the water taken directly from a lake or river without treating it first. Whenever possible, carry water with you that you know to be safe. When you can’t bring water along, choose a purification method and use it carefully. Chlorination and boiling are effective at killing most disease-causing microorganisms. Contact Health Canada to request a copy of WILDERNESS WATER: A GUIDE TO WILDERNESS DRINKING WATER.

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Arsenic levels in Canada’s water sources are typically low, though they have been found to be higher near mining operations and in areas with naturally high levels of arsenic in bedrock, such as in Ontario, Quebec and the Atlantic provinces. Research indicates that exposure to high levels of arsenic is linked to an increased risk of skin, bladder, kidney, liver and lung cancers. **Lead.** In Canada our greatest exposure to lead comes from food, soil and airborne particles. Levels of lead in untreated water are typically low and, therefore, also low in treated water. Lead may, however, make its way into tap water from coming into contact with lead pipes and fixtures in old buildings, especially structures built before the 1950s. Lead may also be present in brass fittings, such as taps, solder that connects copper tubing and that fit some plastic pipes. The use of lead in new plumbing equipment is either banned altogether or restricted. Many municipalities have undertaken programs to remove lead from the public portion of water distribution systems. This means that lead pipes, fittings and solder were replaced right up to people’s private property lines. Homeowners are responsible for removing any lead–based materials on their private property, including any piping or storage tanks underground and in their homes. Research has shown that even small amounts of lead may impact on human health. Infants and children are most at risk from exposure to lead. For this reason the drinking water guidelines set acceptable levels of lead according to children’s susceptibility. Exposure to small amounts of lead over an extended period of time may affect the intellectual and neurological development of the foetus, infants and young children. Lead exposure also affects blood pressure and reproductive functions in adults. **Uranium.** Uranium may be present in water as a result of natural processes, such as weathering or erosion, or as a result of human activities, such as mining and the use of fertilizers that contain phosphate. Levels of uranium in Canadian treated water are typically low. High concentrations have been found, however, in parts of Saskatchewan, Manitoba, Quebec and Nova Scotia. Natural uranium is weakly radioactive. However, its toxicity, especially to the kidneys, is more of a threat to human health than is its radioactivity. The effects of long-term exposure to elevated levels of uranium in drinking water are unclear. There are no clear indications that drinking water, even with elevated uranium levels, has resulted in kidney damage. **Antimony.** Like most other metals, antimony may naturally end up in source waters as a result of weathering and erosion. Human activities, such as mining and industrial and municipal wastewater discharges, also result in antimony deposits. Household piping and non-lead solder may also be a source of antimony. Studies have shown that people exposed to elevated levels of antimony in airborne particles, such as in an industrial workplace, can experience an increase in blood pressure, heart problems and ulcers. Long-term exposure is also linked to increased incidence of menstrual problems and spontaneous abortions. **Fluoride.** Fluoride is a naturally occurring chemical contaminant of many environmental water sources, and its presence is monitored by municipal water systems, particularly if it is added after treatment to meet the recommen- dations of dental authorities. Fluoride as an additive to water is discussed in detail in Chapter 4. For more information on the fluoride controversy visit Health Canada’s Web site and refer to It’s Your Health on fluoride in drinking water and Rachel’s Environment and Health News, Issue 1972, “Fluoridation: Time for a Second Look?” **Nitrates.** Nitrates occur naturally in water, resulting from decaying plant matter. Nitrates are also a main ingredient in commercial fertilizers and can end up in water via runoff from farmers’ fields, septic systems and landfills. When homeowners apply fertilizers to their lawns and gardens, up to 50% of the nitrogen in the product ends up in nearby water sources. In a 1993 Ontario groundwater survey, of 1,300 wells that were tested, 15% contained nitrates at potentially harmful levels. In comparison, nitrate levels in surface water were well below safe limits. Nitrate levels in municipal water supplies are regularly monitored and treatment of raw water supplies with high nitrate levels is successful. For bottle-fed infants, water is their primary source of exposure to nitrates. (For everyone else, food is our primary source of exposure and water is second.) When exposed to high levels of nitrates, infants have suffered from methemoglobinemia, a life-threating condition in which body tissues don’t receive the oxygen they need to survive. Symptoms may include shock, irregular heartbeat, and severe skin discolouration. Babies under three months of age are particularly at risk, as are the foetuses of women in the last three months of their pregnancy. The incidence of this condition in Canada is unknown. Municipal water supplies are regularly tested for metal contamina- tion and treatment plants are designed to reduce naturally occurring levels to a safe level. The well water at your primary source of drinking water, have it tested occasionally for metallic contaminants. If any amounts exceed federal or provincial guidelines, contact your local health authority. Regardless of your water source, if your tap water con- tains lead in excess of the Canadian drinking water guide- lines (0.01 mg/L, or 10 µg/L) take the following precautions: 

- **Lead accumulates overnight in water pipes.** In the morning, flush taps for at least 30 seconds to remove this build-up. 
- **Use cold water for drinking, cooking and other food prepara- tion.** Hot water leaches more lead from plumbing than does cold water. 
- **Consider replacing the lead-based parts of your plumbing system, or install a point-of-use water treatment system that includes the removal of lead.** 

What you can do about metal contamination

- **Have well water tested for nitrates on a regular basis.** According to the Canadian drinking water quality guide- line, nitrate should not exceed 45 mg/L measured as nitrate (or 20 mg/L as nitrite oxidized). Nitrite, formed from nitrate in the body and the cause of methemoglobinemia, should not exceed 3.2 mg/L. The guideline was established based on safe exposure limits for infants, as they are the most susceptible group.

- **Avoid giving water with ele- vated levels of nitrates to infants.** Infant formulas should not be made from groundwater supplies that may have elevated nitrate levels; an alternate source of water is generally recommended.

- **To help reduce nitrate levels in the environment, use natural fertilizers, such as compost, or switch to a lower-maintenance landscape, replacing grass with trees, shrubs and alternative groundcovers. Inquire at your local gardening centre.”
Organic Contamination

Pesticides. Pesticides are chemical and biological agents that are used to control pests such as weeds, insects, rodents, fungi, bacteria and viruses. Pesticides are sprayed on farm crops and animals, lawns and gardens, and golf courses. These chemicals can easily end up in our water sources. They may enter surface waters as a result of accidental spills, improper disposal of leftover chemicals, drifting on air currents for later deposition, and runoff from fields. They may enter surface waters as a result of accidental spills, improper disposal of leftover chemicals, drifting on air currents for later deposition, and runoff from fields. Pesticides can also enter groundwater supplies as a result of leaching from PVC pipes. However, these products are easy to dispose of properly. Fortunately, these products are easy to dispose of properly.

Organotins. Organotins are a group of organic compounds that contain tin. In Canada we import organotins to use as stabilizers in polyvinyl chloride (PVC) plastics, as ingredients in wood preservatives and as paint on boats to keep debris from clinging to them. Exposure to very high levels of certain organotins can cause brain damage. A Health Canada survey did not find any organotins in water samples of untreated or treated water supplies from five municipalities in Canada, but did find trace amounts in approximately 50% of the homes that were tested. It was suggested that organotins may enter water supplies as a result of leaching from PVC pipes. However, the study also found that the levels of organotins diminished within three months and Health Canada concluded that leaching from PVC pipes was not a major source of contamination. There is no Canadian Drinking Water Guideline for organotins.

Volatile organic compounds. Volatile organic compounds (VOCs) are among the most frequently detected organic contaminants in groundwater. VOCs are chemicals that readily evaporate and include such substances as trichloroethylene and tetrachloroethylene. These two chemicals are found in many household products and are also used as solvents by the metal-degreasing and dry-cleaning industries. VOCs are often present at high levels in the leachate from municipal landfills. The leachate may enter groundwater or surface water, thus contaminating water supplies and potentially degrading into more toxic substances. Trichloroethylene and tetrachloroethylene are potentially harmful to human health when inhaled at high concentrations. Trichloroethylene is a probable human carcinogen; tetrachloroethylene is a potential human carcinogen. If people were exposed to water contaminated with VOCs at levels exceeding the current Canadian drinking water guidelines, they might be at significant health risk. The inhalation of these chemicals when showering can also be an exposure route. Fortunately, however, at the levels typically found in Canada’s drinking water, the risks associated with exposure are quite low.

Radioactive Contamination

Water may become contaminated with radioactive atoms (called radionuclides) from both natural and human sources. Exposure to such radionuclides is associated with a slight increased risk of cancer and genetic disorders. Consuming water contributes only a very small amount of our total radiation exposure. Most radionuclides in our water are there naturally as a result of the decay of uranium and thorium. Provinces and/or municipalities in Canada are responsible for monitoring radionuclide levels in drinking water. Some testing has been discontinued because the levels of radioactivity have been consistently low. Nuclear power reactor operators are responsible for monitoring radionuclide levels in the local environment and reporting the results to the Atomic Energy Control Board. In Canada the potential risk associated with radioactive substances in water are extremely low.

What you can do about organic contamination

Organic contaminants are present in many of the products we use in and around our homes. The pesticides we spray on our lawns and plants, the cleaners we use in the kitchen, bathroom and laundry room, the paints and stains we put on our walls, furniture, and outdoor surfaces — all of these, and many others, can contaminate water sources if disposed of improperly. Fortunately, protecting water supplies from contamination with these products is easy:

Never pour these chemicals down household drains, toilets, or outdoor storm sewers. If these chemicals directly enter our water supply systems they can pollute the very drinking water that we rely on. Dispose of chemicals properly by taking them to the local municipal hazardous waste collection depot.

While these products can be removed from water sources with the use of carbon in filter beds and filters, an even better alternative is to avoid the use of products that will cause contamination. Use environmentally sound cleaning products, for example, or chemical-free paints and finishes.

There are many ways to reduce your use of pesticides:

• Replace your lawn grass with a lower-maintenance landscape, including alternative groundcovers, trees and shrubs. These reduce the need for pesticides and also require less watering.

• Let your grass grow to a height of four inches before cutting it. Tall grass is more resistant to weeds and disease and also requires less water.

• Use insecticidal soaps, non-toxic oils, and other natural methods to deal with garden pests. Consult a book on organic gardening, or your local nursery, for more suggestions.

• Add compost to your lawn and garden to improve their resistance to pests and disease.
If you’re like most people in Canada, you have easy access to a good supply of drinking water. You just turn on your tap and out comes the water, ready to be used for drinking, bathing, and cooking. But not everyone in the world is as fortunate as Canadians. In fact, there are more than two billion people who don’t have an adequate supply of water.

Many of these people also don’t have access to a safe supply of water. Other people, though they have a source of clean water, don’t have water close to where they live. These people have to carry their water by hand from the source to their homes. They might spend most of their day carrying water from the source to where they live. For others their source of water is both dirty and far away from their homes.

So just how does our water get into our homes? Most people in Canada get their water from public utilities. Utilities are companies or government agencies that are responsible for providing such things as electricity, gas or water to the public.
The Process of Water Treatment

1. Intake. Water is taken from the source through a large pipe and drawn into the treatment plant. A screen at the end of the pipe prevents logs, fish, and plants from being drawn in. If the source is groundwater, the soil and rocks do the "screening" naturally as the water travels under the Earth's surface. Depending on the quality, groundwater may not require further treatment.

2. Chemical addition. Chemicals such as chlorine and aluminum sulphate (alum) are added and mixed into the water. These chemicals kill bacteria in the water, improve its taste and odour, and cause any tiny particles in the water to clump together and settle.

3. Coagulation and flocculation. The chemicals that were added to the water cling to any substances floating in the water. The process of things sticking together like this is called coagulation. Then the particles begin to stick to each other and form larger particles. These larger particles are called floc.

4. Sedimentation. The water and the floc flow into a sedimentation basin. The water sits here for a time to allow the floc to settle to the bottom. In addition to removing particles from the water, this process also removes bacteria, which typically attach themselves to the particles.

5. Filtration. The water flows out of the sedimentation basin and into the filtration area. The water is filtered through layers of sand, gravel and other media such as anthracite or activated carbon to remove any remaining particles.

6. Post-treatment disinfection. The water flows from the filtration area on its way to the storage area and the distribution system. Along the way, a small amount of chlorine or other chemical disinfectant is added. The disinfectant kills any bacteria that are still in the water; a small amount remains in the water to kill any new bacteria that may be picked up while the water travels to people's homes and workplaces.

Water is sampled and tested at various stages throughout the treatment process. Sampling is done to make sure that all stages of the process are working properly and that the water is safe before it leaves the plant and makes it to consumers.

**Figure 5:**
**Amount of Water Treated in Canada Each Day and Its Uses**

<table>
<thead>
<tr>
<th>Category</th>
<th>Water Treatment (litres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>140</td>
</tr>
<tr>
<td>Watering Bathing</td>
<td></td>
</tr>
<tr>
<td>Cooking Washing</td>
<td></td>
</tr>
<tr>
<td>Recreation</td>
<td></td>
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<tr>
<td>Industrial</td>
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<td>Factories</td>
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</tr>
<tr>
<td>Commercial</td>
<td>52</td>
</tr>
<tr>
<td>Restaurants Sports</td>
<td></td>
</tr>
<tr>
<td>Public Use</td>
<td>53</td>
</tr>
<tr>
<td>Fighting Fires Parks</td>
<td></td>
</tr>
</tbody>
</table>

**Drinking Water Distribution**

After water is treated it is distributed—moved from the treatment plant to people’s homes and businesses.

Treatment plants, reservoirs and holding tanks are built on high ground where possible. This saves energy because gravity can be relied on to naturally pull the water down from the holding areas and through the pipes to the customers. Sometimes water may be pumped uphill and then gravity is allowed to take over to feed the water back down. Similarly, pumps are used to pull water up from natural underground aquifers. They are also used in hilly places to keep water moving until it can rely on gravity once again.

Water travels through large pipes called mains, or water mains. Computers are often used to control the amount of water flowing through a main at a given time. Large valves are also used to control the flow of water. Valves are like large faucet handles that can be turned off or on to varying degrees, thus regulating the water flow. If a water main breaks or there are other problems, the water for a particular area can be shut off until repairs are completed.

Just as water is tested at various points in the water treatment process, it is also tested at various points in the distribution system. Sampling is done to make sure that the water is still safe when it reaches consumers. If contamination occurs within the distribution system, the testing will reveal this and steps can be taken to protect people from drinking water that isn’t safe. Disinfectant is often added at various points within large distribution systems to prevent bacterial contamination.

Utilities measure the amount of water that they pump each day. This is especially important when the water is drawn from a groundwater source. If too much is taken from an aquifer the ground may become too dry, compact under its own weight, and collapse, thus causing damage to any structures on the surface.

**Concerns with Drinking Water Treatment**

We know that we are very fortunate to have modern water treatment and distribution systems. Many good things have resulted from these systems, including the virtual elimination in Canada of serious waterborne diseases such as cholera and typhoid. Our methods of water treatment and distribution have been described as among the major health-related advances of the past century.

But these benefits have not come without costs. In recent years, people have become increasingly concerned about negative effects that may result from our current drinking water treatment methods. There has been particular concern around the addition of chlorine to our water, as well as aluminum and fluoride. Studies have revealed that current chemical disinfection processes have the potential to create by-products that may be harmful to human health.

When weighing health benefits and risks, the use of such chemicals is still recommended by health authorities. Ideally the use of these chemicals is optimized, that is, treatment processes are adjusted to reduce quantities of needed chemicals as much as possible and yet still maintain the benefits of their use.

**Small waterworks**

Many Canadians depend on small drinking water systems on a daily basis and almost all of us use them as we travel, visit camp sites or use other facilities in smaller centres or rural areas. Due to their size and remote locations, small waterworks face unique challenges. They must supply safe drinking water to sparsely populated communities, often with a much smaller budget than large municipal systems.

Often unable to invest in other treatment methods, smaller systems often find that they must use chlorine to compensate. One potential problem faced by smaller systems is over-chlorination, which leads to higher than desired levels of chlorination disinfection byproducts unless there is prior removal of organic matter. And with the increased presence of protozoa like Cryptosporidium and Giardia, smaller systems may need to take additional steps to provide the assurance of safe drinking water.

Most jurisdictions across Canada have set specific requirements for small waterworks. Check with the local ministry of environment or public health unit for more information.

Chlorine

For more than 80 years chlorine has been the most commonly used disinfectant in water treatment. It is currently used in 98% of treatment plants in Canada. Very effective at killing any bacteria found in incoming source water, chlorine offers the added benefit of remaining active in the water as it moves throughout the distribution system, thus providing ongoing protection from contamination even as the water flows from our taps. Chlorine also controls unpleasant tastes and odours in our water. And, it is relatively inexpensive to use.

Unfortunately chlorine isn’t all good news. We’ve learned that when chlorine is added as a disinfectant to water with a high organic content, a number of other substances form as a result. Called “disinfection by-products,” many of these substances have been discovered to be harmful to human health. (It should be noted that, in some cases, disinfection by-products may also be associated with alternative disinfectants, as discussed elsewhere.)

These substances are created as a result of an interaction between chlorine added to the water and organic matter naturally present in the water, such as decayed vegetation and human and animal wastes. The concentration and types of by-products that are formed in chlorinated drinking water is influenced by a number of factors:

• the amount and type of organic matter in the water;
• the source of the water (there is typically less organic matter in groundwater and large lakes and more in surface water taken from rivers and small lakes);
• the time of year (there is usually less organic matter in water during the winter and more following heavy rains in spring and fall);
• the effectiveness of water treatment stages, such as coagulation and filtration, that take place ahead of the chlorination step; and,
• the type of disinfectant used.

Disinfection by-products that are formed in water as a result of chlorination include trihalomethanes (THMs), haloacettes, haloacetonitriles, haloaldehydes, haloketones, haloaldehydes, and halohydroxyfuranes. THMs and haloacetates are the most common by-products found in chlorinated water. The THMs most commonly found in drinking water are chloroform, bromodichloromethane, chlorodibromomethane, and bromoform. Brominated disinfection by-products are considered to be among the more harmful, but more research is needed to confirm this.

In the interest of protecting water as it travels through the system, a small amount of chlorine sometimes continues to be added to water at various intervals during distribution. The result, however, is that the concentration of disinfection by-products may continue to increase until the time that water leaves the treatment plant to the time it reaches the consumer. The concentration of disinfection by-products may increase by 25 to 100%. To avoid this, many systems add ammonia to the system. The result is that the residual chlorine combines with the ammonia to form chloramine.

Chloramine is a weaker but more stable disinfectant than chlorine that controls bacteria risk while producing lower levels of THMs. It is very effective at maintaining a residual level of disinfectant in drinking water systems. Smaller communities may rely on chloramination as the only treatment step. In such cases, depending on the amount of chlorine used, the type and amount of organic material found in the raw water and the time of year, the levels of disinfection by-products are often found to be elevated.

As compared to other sources such as food and air, drinking water is a minor source of most pollutants. It is, however, according to Health Canada’s publication, Health and Environment — Partners for Life (1997), our primary source of exposure to some microorganisms and to water disinfection by-products. Among the most serious health risks associated with disinfection by-products are cancer and reproductive effects.

The Great Lakes Basin Cancer Risk Assessment Study, launched in 1992 by Health Canada, revealed that people, who over a long period of time drank surface water that has been chlorinated and that contains high levels of THMs, have an increased risk of developing bladder cancer and possibly colon cancer, but not rectal cancer. The study, which was focused on cancer risk in the Great Lakes Basin, concluded that between 10 and 13% of all cases of bladder and colon cancer in Ontario may be due to long-term exposure to chlorinated water. The researchers weren’t able to tell, however, whether the increased risk of cancer was due to THMs or some other substances in the chlorinated water.

As a result of its continued research, Health Canada has described chlorination by-products in drinking water as a moderately important public health problem. Researchers are continuing to study the link between chlorinated tap water and cancer.

In addition to cancer, there is some concern that disinfection by-products, and THMs specifically, may be linked to reproductive health effects. A study of five thousand pregnant women in California reported that there was an association between the incidence of spontaneous abortion and the consumption of tap water. In fact, women who drank five or more glasses of cold tap water containing high levels of THMs were almost twice as likely to suffer a spontaneous abortion as those women who drank less tap water.

According to Health Canada, levels of THMs are used by many drinking water authorities as indicators of the total level of all chlorinated disinfection by-products present in the water. Health Canada is beginning to evaluate chlorinated disinfection by-products other than THMs, such as halogenated acids and haloacettes and haloacetonitriles, to determine whether and to what degree they pose a health risk.
Unfortunately the research to date on the links between disinfection by-products and reproductive health effects has not been very extensive. Further studies are needed to determine the extent of these and other effects on human health.

As we have come to understand the potential hazards associated with its use, many plants (and certainly all large ones) have chosen alternatives to pre-treatment disinfection with chlorine, such as the use of ultraviolet light technologies (see “Alternatives to Chlorine Disinfection” on opposite page). Overchlorination of drinking water is a rare occurrence these days. Advances in our technical knowledge and ability has meant that water treatment plants are able to optimize the amount of chlorine that is used in both the pre- and post-treatment phases, adding the minimum amount of chlorine to keep our water safe. On occasions where overchlorination does occur, it seems that too much may be better than too little.

While there are serious health effects associated with overchlorination of drinking water, the health effects of not disinfecting our water are even more serious. It is estimated that the risk of disease from drinking non-chlorinated water is 100 to 1,000 times greater than that from exposure to disinfection by-products. In their publication, HEALTH AND ENVIRONMENT — PARTNERS FOR LIFE (1997), Health Canada reports that, “according to some experts, chlorine is the most effective public health measure ever implemented and ‘has saved more lives than any other single chemical.’” Therefore, instead of reducing disinfection of our water, it is a better strategy to find more effective ways of removing the organic matter that leads to the production of these by-products, such as protecting the source of the water from becoming contaminated in the first place.

Alternatives to Chlorine Disinfection

Concerns with the formation of disinfection by-products as a result of adding chlorine to water has lead to a search for other options. Alternatives to chlorine disinfection include the use of disinfectants other than chlorine, such as chloramine, chlorine dioxide and ozone, and the use of non-chemical processes, such as ultraviolet light.

Chloramine. Chloramine is a mixture of chlorine and ammonia and is less reactive with organic materials than chlorine alone. As a result, it is associated with the formation of disinfection by-products at levels lower than those associated with chlorine use. Similar to chlorine, it has a residual effect and continues to disinfect throughout the distribution system. Because it is a weaker disinfectant than chlorine, chloramine is not as suitable as a primary disinfectant at the treatment stage. However, the fact that it is less reactive and thus more stable than chlorine may mean that it is better suited at providing protection in the distribution system. Some studies have in fact shown it to be more effective than chlorine in preventing growth of bacterial hazards within the distribution system. Chloramine is, however, highly toxic to fish and, where leaks or spills have occurred in fish bearing bodies of water, it has killed large populations. For this reason, prior to using it in aquariums, it has often been suggested that chloramine be evaporated. However, chloramine is very persistent and it is better to use chemical means to protect aquarium fish. Chloramine is also is associated with health risks to humans, but there is a Maximum Acceptable Concentration guideline that establishes a level that is protective to health.

Chlorine dioxide. As compared to chlorine, chlorine dioxide is equally or more effective at neutralizing bacteria, viruses and protozoa. In addition, it is effective at dealing with parasites such as Giardia and Cryptosporidium, which are highly resistant to conventional chlorination treatment. Another advantage is that it is not associated with the formation of chlorination by-products such as THMs.

However, chlorine dioxide is not an ideal alternative to chlorine because it generates its own by-products, including chlorate and chlorite, which are associated with a variety of adverse health effects. It is considerably more expensive than chlorine and, because it cannot be transported, must be manufactured on the site where it is to be used.

Ozone. As compared to chlorine, ozone is equally or more effective at neutralizing bacteria, viruses and protozoa. In addition, it is effective at dealing with parasites such as Giardia and Cryptosporidium, which are highly resistant to conventional chlorination treatment. In addition to microbiological contamination, ozone is effective at removing colour, taste, odour, and a range of trace organics. A significant advantage of ozone over chlorine is that the use of ozone does not result in the production of chlorination by-products.
Among the drawbacks of using ozone are that it is generally more expensive than chlorine and its effectiveness is short-lived as it does not have a residual effect after the water leaves the treatment plant. For this reason, it is not used in the post-treatment stages of water distribution. Ozone can be made more effective, however, with the addition of low levels of chlorine or chloramines to the water before it is distributed.

In addition, as ozone is effective at breaking down organic matter, it may result in providing increased nutrients for bacteria to feed on such that they will grow and multiply. Depending on the source water, an extra process may be required to remove these extra nutrients and restabilize the water.

Another potential drawback of ozone is that it can result in the production of some by-products, including bromate and formaldehyde, both known to cause cancer. It is likely that, at current levels, the risk of cancer from exposure to bromate in drinking water is negligible. However, if bromate levels increase as a result of water utilities switching from chlorination to ozonization, there is a potential for the risk to increase. Formaldehyde, on the other hand, is considered unlikely to cause cancer in humans as a result of consuming drinking water.

Ozone clearly has major benefits as a substitute for chlorine, but it is by no means a perfect alternative. Further evaluation is required to determine its impacts on water quality and human health.

**Ultraviolet light.** Exposing water to ultraviolet (UV) light is effective at killing some bacteria, viruses and fungi. Lamps that contain mercury vapour are used to generate electromagnetic radiation, which acts as a disinfectant. UV light is commonly used as a disinfectant by the beverage industry. It is also commonly used in fish hatcheries to disinfect water without the use of chemicals, such as chlorine, that are harmful to fish.

UV light is also used for drinking water treatment, although most treatment plants currently using UV are located in Europe. It is expected that increasingly more North American installations will begin using this treatment as recent research demonstrates that UV is very effective against *Giardia* and *Cryptosporidium*. Similar to ozone, however, UV light does not have a residual effect to protect water once it leaves the treatment plant. This is addressed by the addition of chlorine at low concentrations, after UV treatment, to provide residual post-treatment protection in the distribution lines.

**Membrane filters.** Membrane systems involve passing water through a membrane filter that has a pore size smaller than the substance being removed. Membrane filtration systems for drinking water include nanofiltration systems that remove colour and THM precursors (and can also be used to soften water), ultrafiltration systems for the removal of viruses and emulsions, and microfiltration systems for the removal of *Cryptosporidium*, *Giardia*, bacteria, iron and manganese.

**Fluoride**

While aluminum is naturally deposited in water as a result of weathering and erosion, the most common source of this metal in our tap water is the water treatment process. Most treatment plants using surface water add aluminum compounds, such as alum (aluminum sulphate), to help remove particles and the microorganisms attached to them, in a process called coagulation and flocculation. Aluminum compounds are also used to remove organic matter that occurs naturally in the water, thus reducing the formation of trihalomethanes and other disinfection by-products.

Alum and polyaluminum chloride are the most widely used coagulants because they are effective, readily available and fairly inexpensive to use. However, if the use of these substances is not properly optimized in the treatment process to ensure that large residuals are not left over, the result can be elevated levels of aluminum in our drinking water. Other chemical coagulants (e.g., ferric chloride) are available that may be safer for human health, but they are not always as effective, easy to use, available and inexpensive as aluminum.

We currently don’t know what, if any, health effects are associated with exposure to aluminum at levels typically found in tap water. Aluminum has been linked to Parkinson’s disease, Lou Gehrig’s disease and Alzheimer’s disease. A number of studies found a small increased risk of Alzheimer’s disease in areas with high levels of aluminum in drinking water. It isn’t clear, however, that aluminum is the cause of the disease, only that the two seem to be connected in some way. Health Canada is undertaking studies to try to determine a safe level of aluminum in tap water.

In the meantime, as a precaution, the Drinking Water Subdivision has established an operation level for plants using aluminum coagulants. It is possible that dietary sources may be more important than drinking water as an avenue of exposure to aluminum.

**Aluminum**

Fluoride has been found to make teeth more resistant to cavities, and for this reason began to be added to Canada’s drinking water in the 1940s and 1950s to achieve dental benefits. Roughly 40% of Canadians receive drinking water that has fluoride added to it. Other sources of fluoride include food (traces amounts are found in almost all foods) and toothpaste.

In some children, exposure to low levels of fluoride can cause moderate to severe discoloration of the teeth (fluorosis). At high levels, prolonged exposure can lead to skeletal fluorosis, a condition in which the bones become increasingly dense and brittle. Symptoms range from mild (pain and stiffness in the joints) to severe (complete rigidity of the spine, skeletal deformities, and increased risk of fractures). According to Health Canada, levels of Fluoride in this country are at least 20% lower than those associated with negative effects on the skeleton.

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Aluminum clearly has major benefits as a substitute for chlorine, but it is by no means a perfect alternative. Further evaluation is required to determine its impacts on water quality and human health.
Chapter Five:

What Else Can We Do?

Protection at the Source

As described in the 1999 report of the British Columbia Auditor General, Protecting Drinking-Water Sources, there are four main components to the reliable provision of high-quality drinking water:

- protection of drinking water sources;
- appropriate water treatment;
- sound and well-maintained water distribution systems operated by trained staff; and,
- adequate water quality testing.

While much attention has been paid to drinking water treatment and distribution, perhaps not enough effort has been directed toward protecting water at the source, before it even becomes our drinking water. Source protection requires that we understand those activities that may harm water quality and that we then take action to eliminate, or at least minimize, the detrimental effects. The higher the quality of the source water, of course, the less treatment is required and the cheaper it is for consumers. This speaks to the importance of keeping our water sources as clean as possible.

As stated in the Auditor General’s report, “Water quality is intimately linked to land use. When rain falls to Earth, it can pick up contaminants from the atmosphere, from natural sources, and from a whole range of human land uses before it enters streams and lakes or seeps underground into aquifers. Effective water protection hinges on managing the land uses on the surfaces over or through which water flows. Accordingly, one key condition for successful water protection is integrated management of both water and the land uses that affect it.”
Land Uses That Can Harm Drinking Water Sources

The following list of possible sources of water contamination is drawn from Protecting Drinking-Water Sources, a 1999 report by British Columbia’s Auditor General.

Farms. Animal-raising operations (pigs, chicken, cattle) can be a major source of nutrient overload in water, particularly when large quantities of manure are mixed with water and sprayed on land and some of this material leaches into ground water or runs off into streams.

- Cattle grazing on steep slopes can increase runoff and sedimentation of streams.
- Feedlots and factory farms can contaminate water with faecal matter that may carry bacteria such as E. coli or pathogens such as Cryptosporidium.
- Runoff triggered by rain or melting snow on cleared farmlands may wash sediment into water.
- Pesticides and herbicides can leach into groundwater or wash into streams or storm sewers (urban lawns, golf courses, parks and gardens are also common sources).

Gravel pits and mines. Gravel pits or other digging operations can disturb soils, causing sediment to wash into nearby water bodies, or expose groundwater and surface water to other contaminants such as acid-generating waste rock.

Urban developments. Cleared land for urban developments may leave soil exposed for months at a time, leading to significant amounts of sediment washing into streams.

Poorly constructed or uncapped wells. These are common avenues by which groundwater contamination can occur.

Pavement. Roads, parking lots, airports and other paved surfaces can accelerate runoff into nearby waters. The faster and heavier the runoff, the more debris, including sediment and pollutants, is carried into the water.

Logging. Logging and associated road building can increase erosion and turbidity and, in some cases, cause algal blooms. Forest fires, like prairie grass fires, can burn off ground cover, leading to increased erosion.

Air pollutants. From cars to factories, pollutants pumped into the air can mix with rainwater or snow or be carried by wind into water bodies.

Sewage treatment plants and factories. A variety of chemical and other contaminants found in sewage and industrial effluents can enter water bodies that also serve as drinking water sources.


The Economics of Water Protection

Good protection of water sources is essential to the cost-effective provision of safe water. If we are careful to protect our water sources, communities that currently have good sources, especially good ground-water sources, will continue to have good drinking water without requiring expensive additional water treatment beyond disinfection. Even communities that need to add further treatment can save money through good source protection. Water with low turbidity and low levels of bacteria, viruses and parasites can be treated successfully by filtration and disinfection. However, with poor quality source water, other treatment techniques become necessary, and the cost of building and operating filtration plants increases.

In short, good protection of drinking-water sources increases the reliability of our water supplies by adding to their levels of protection. It can also reduce, delay or avoid the cost of additional water treatment beyond disinfection. Water treatment should be considered as a way of improving the protection given to water consumers, rather than a reason to neglect source protection.


It is important to note that there are significant differences between choosing a water treatment device if your source is well water versus if your source is treated municipal water. If your source is well water, then a treatment device may be essential to, for example, soften water and remove contaminants. If your source is treated municipal water, then choosing a treatment device is a matter of choice rather than necessity.

Home Treatment Devices

Many people, even those consuming regulated and monitored public water supplies, are so concerned about the quality of their drinking water that they have decided to take matters into their own hands. Every year approximately 100,000 Canadians purchase water treatment devices with the hope that these systems will make their water safer to drink. With the exception of ceramic filter and ultraviolet light devices, most home treatment systems are designed for use on water that is already treated before it arrives at individuals’ homes or that is otherwise microbiologically safe. These devices often treat only the aesthetic qualities of water. For example, they remove residual chlorine and thus improve the taste or odour of tap water.
Choosing a Home Water Filtration System

There are hundreds of products sold in Canada claiming to improve your drinking water. So how do you go about choosing the system that is right for your needs?

Well, first you probably want to know whether you actually need a drinking water treatment device. Many people are buying home treatment devices because they are interested in having better tasting water. You’ll want to determine whether there is a problem with the water coming out of your tap. This information may be already available from your local utility. Many public utility commissions and municipal water suppliers now have this information posted on their Web site. You might also check with the Web site of your provincial ministry that is responsible for drinking water. Recent legislation requires that drinking water information be made available by these ministries to the public.

If the information is not readily available, you may have to have the water tested yourself. The way you go about having your water tested, the cost involved, and the government body responsible vary from one province to another.

Testing Your Water Province by Province

Given recent concern over drinking water in Canada, regulations and testing are changing very quickly. The information that follows was accurate as of January 2001. Check with your provincial ministry responsible for drinking water to obtain the most up-to-date information.

Ontario. Public Health Units offer free water testing for microbiological organisms to owners of private wells. The Ministry of the Environment will test for other substances if you can substantiate a problem. If you are just checking the quality of your water, you will have to go to a private lab for chemical testing. The Ministry of the Environment can provide a list of accredited laboratories.

British Columbia. If you’re just checking the quality of your water, you will have to go to a private lab. The provincial Health Office can provide a list of approved laboratories. The B.C. Health Ministry also approves labs for testing.

Alberta. If you have a health problem, call the Regional Health Authority’s Environmental Health Program. They will test if they agree you might have a problem. If you’re just checking the quality of your water, you will have to go to a private lab.

Saskatchewan. For well water, if you want to test bacterial quality, go to your municipality’s town office. Pick up an information form and a bottle. It will cost $16 to have your water tested by a provincial lab. Also, the Rural Water Advisory Programme, run by SaskWater Corp, costs $100 to have them come out and assess your well or surface water source at your farm or cottage.

Manitoba. All private wells are the responsibility of the homeowner. The government does provide assistance in interpreting the results of tests. The government also provides brochures and information sheets. Municipal water is already tested. The government does random sampling. Costs to homeowners of testing are subsidized by the government.

Quebec. Take your samples to a private lab. You can ask your municipality to come and check if you think you have a serious problem. Quebec’s Ministry of the Environment accredits water testing laboratories. Look for accreditation as a “Centre d’expertise en analyse environnemental du Quebec.”

New Brunswick. If you want your water tested, it’s a private initiative and you have to pay the lab fee.

Nova Scotia. Citizens are responsible for the cost of testing, whether the source is municipal or a well.

Prince Edward Island. The province owns the only water testing lab. They will test your water for a subsidized fee: $12 bacterial, $25 for water chemistry. You can pick up test bottles from PEI Water Resources or from nine service centres around the province. Staff will go out and test if the problem could be serious. The results are mailed to you, but if something significant is found, they will phone you.

Newfoundland and Labrador. Water testing is up to the individual homeowner. You will have to pay the cost.

Contact information for the testing facilities and government offices mentioned here is provided in Chapter 9.

Source: Marketplace.

http://cbc.ca/marketplace/files/home/waterfilters/cost.html

Types of Water Filtration Systems

Once you’ve decided to purchase a water filtration system, you’ll next have to decide what kind to buy. And with hundreds of products on the market, you’ll find yourself needing to do a bit of research before you can make a choice. You’ll want to consider, of course, which type of system best suits your needs depending on what substances you are trying to remove.

Activated carbon system. With this system water passes through a filter containing granular carbon. Carbon has long been known to absorb impurities and was used by sailing ships when storing drinking water during long voyages. The carbon in the filter has been specially activated, thus increasing its capacity and tendency to attract chemicals and impurities. The carbon is often used in combination with ion exchange resins to increase the amount of substances that may be removed.

This is the type of filter that is often used in refillable pitchers and personal water bottles, and that is mounted onto the tap. The activated carbon system is by far the most popular choice for the average consumer. It is widely available, easy to install, and affordable. Activated charcoal systems are the least expensive filtering option, costing between $20 and $60 for the initial purchase. There are ongoing costs to replace the filters.

Activated carbon systems (also referred to as activated charcoal systems, or granular activated carbon systems) can reduce, but not totally eliminate, pesticides, volatile organic compounds (VOCs), synthetic organic compounds, some radionuclides, flouride and some metals. This type of system is best suited to areas where water comes from a treatment plant. It is not recommended for those who rely on well water.

A disadvantage to this system is that the filters can actually add contaminants to the water, especially if improperly maintained. As water passes through the filter, bacteria are trapped in the carbon granules. Because the filter is warm and moist and exposed to oxygen, it offers an ideal environment for the bacteria to multiply. This situation is made worse by the fact that the filter traps any organic matter that may be in the water, providing the bacteria with a source of food. The result is that the filtered water may contain bacteria, especially that which flows from the tap the first time in the day. Also, once the carbon becomes saturated, competition between incoming contaminants and those already adsorbed may result in the release of contaminants back into the water.

This is why it is very important to change the filters with the frequency recommended by the manufacturer. The frequency for changing a filter depends on the amount of carbon it contains, the quality of the incoming water and the amount of water that passes through the filter. A Health Canada study found that water that had passed through an improperly maintained activated carbon system could contain 2,000 times higher levels of bacteria than unfiltered water. The good news is that studies suggest these bacteria don’t typically cause any problems for most people. For those whose immune systems are compromised, however, there is evidence to suggest that there may be a risk.

Because these systems are limited in the types of compounds they can effectively remove, it is essential that the water contaminants be determined prior to the purchase of such a system. If your water is municipally treated, sufficient contaminants will already be removed to ensure your water is safe to drink. Such systems may be used, then, to reduce the presence of substances beyond levels considered safe by the municipality. This type of system is not recommended for those who rely on well water.

Ceramic filters. Ceramic filter systems are installed under a sink and attached to one faucet. They are much more expensive than activated carbon systems, which are used in refillable jugs or attached directly to the faucet. The ceramic element is designed for the removal of microorganisms.

Ceramic filter systems require a lot of maintenance. They are fragile systems that need to be cleaned regularly. They are often combined with activated charcoal systems or cloth filters to remove materials such as lead.

Reverse osmosis. This system involves forcing water through a small membrane that blocks 90% of bacteria and minerals. Most systems have two additional activated carbon filters, one each on either side of the membrane, to trap any impurities that make it through the reverse osmosis membrane. Unfiltered water remains on one side of the membrane while filtered water passes through to the other side. These systems are installed most frequently under a sink, and sometimes where the water comes into the home.

Reverse osmosis systems are recommended for water with a high mineral content. As they are effective at removing nitrates, they are often suitable in agricultural areas and for private water systems.

An advantage of reverse osmosis systems is that the membranes last from one to eight years, depending on the quality and quantity of water being filtered. This is much longer than for other systems. However, regular maintenance is required to keep external surfaces clean. Such maintenance can damage the seals around the filter, resulting in the leakage of contaminated water into the system without filtration.

There are other disadvantages. One concern with reverse osmosis systems is that the reservoir provides a breeding ground for non-pathogenic bacteria such as pseudomonas bacteria. This particular type of bacteria flourishes in water that is low in nutrients or relatively pure — exactly the type of water produced by reverse osmosis, as well as distillation, systems. Fortunately these bacteria are relatively harmless to healthy individuals, but may cause some harm to individuals whose immune systems are compromised.

Until recently, another disadvantage has been that large quantities of water were wasted. In the early 1990s, statistics showed that 11 to 38 litres were used to produce 3.78 litres of filtered water. Some reports suggest that the systems have improved considerably, using 7 litres to produce 3.78 litres of treated water.

Distilled water systems. Distilled water systems work by heating water to boiling and then cooling and condensing the steam into liquid, thereby removing all dissolved minerals and bacteria. Distillation is effective at removing all non-metallic inorganics, metals, microbiological contaminants, physical contaminants, synthetic organic compounds, most pesticides and radiological contaminants.

Similar to reverse osmosis units, distilled water systems can be installed either at the faucet or at the point where water enters the building. Distillation systems are most often installed at the faucet.
A Word About Water Softeners

Municipal water is required generally to be “softened” at the treatment plant. If your water comes from a well, however, it may have a high mineral content, also referred to as “hard” water. You’ve probably seen evidence of it — a whitish-gray film or crust that builds up on your glass coffee pot, inside your kettle and on shower doors and walls. Mineral deposits in the water are left behind when the water evaporates and causes this film or build-up.

Water softeners or conditioners are used to treat water with a high mineral content. Most conditioners use an ion exchange process whereby sodium is put into the water in exchange for the calcium and magnesium that cause water hardness. This exchange process changes the chemical makeup of the water. Water softeners also remove some metals. Salt, or sodium chloride, is used to regenerate the treatment unit. Depending on the quantities and disposal techniques, disposal of the water softener salt solution back to a groundwater source may raise concerns about saltwater contamination of the aquifer.

Excessively hard water can be a problem, causing mineral scale on sinks, water pipes, and other household appliances. The mineral build-up can reduce the energy efficiency of water heaters, reduce the life of various appliances, including water treatment systems, and make soaps and detergents less effective. On the other hand, softened water can be corrosive because of the sodium, leading to plumbing system failures (particularly hot water tanks) over time. Potassium chloride can be used in place of sodium chloride, but it is more expensive.

However, there are some important benefits to hard water. For one, people who drink hard water may be less prone to heart disease. They also seem to develop stronger teeth and bones than those who drink soft water. Further, mineral build-up in pipes that results from hard water serves to prevent any lead in solder joints from getting into drinking water.

It is generally not recommended that individuals drink water directly treated by a water softener. Water to be used for drinking should be by-pass the water softening system. Individuals on low-sodium diets should especially avoid softened water since the process adds sodium to the water.

Ultraviolet (UV) light. Systems that use ultraviolet light are not actually filtration devices, but rather disinfection methods. Water passes through a clear cylinder where it is exposed to ultraviolet rays from a lamp. The light disinfects the water by killing most of the bacteria and viruses, and possibly protozoa as well. Such systems are appropriate for those whose water is taken from private wells rather than municipal treatment systems.

UV light systems are most often installed at the point of water entry into the home, though they may also be installed at point of use. The minimal cost for a basic system is $1000. Their effectiveness depends upon the length of time there is of water is exposed to the light, the intensity of the light, the type and number of organisms that are present in the water, and how frequently the systems are cleaned (sediment build-up reduces the effectiveness of the UV lamp). Bulbs need to be replaced every year.

Recent research suggests that UV is very effective against Giardia and Cryptosporidium. UV systems can be used at the tap as an additional barrier against Cryptosporidium in particular, especially as it is very resistant to chlorine treatment. Ultraviolet systems are less effective at disinfecting water that contains iron or a high amount of suspended particles (i.e., turbid water) and for this reason they are often operated in conjunction with a water filter.

Certification

Once you’ve decided on the type of filtration system you want to purchase, you’ll next want to choose a specific brand and model. In doing this it is highly advisable that you choose a system that has been certified.

Unfortunately, this isn’t nearly as easy as it sounds. Currently, there are no regulations in Canada to ensure that the system you buy is safe and effective and that it performs in the way that it claims. Water filtration devices do not undergo any government approval process, though Health Canada has been pushing for certification requirements for some time. For now, certification remains entirely voluntary.

In Canada, there are three main organizations that certify water filtration products: Canadian Standards Association (CSA), Underwriters’ Laboratories (UL), and National Sanitation Foundation (NSF) International. Of these, NSF has the toughest standards and tests more products than any other company.

The greatest advantage of this type of system over others is that it is the most effective at removing the largest number of chemicals. This doesn’t come without significant costs, however. These systems are on the higher end of the scale when it comes to cost. They can be expensive to purchase, running to at least several hundred dollars. They are also expensive to operate as they use a lot of energy to produce only a small amount of filtered water.

Another disadvantage is that the process is time-consuming, taking about eight hours to produce several litres of drinking water. The distillation unit must be cleaned regularly, often with corrosive chemicals, as the minerals of the scale when it comes to cost. They can be expensive to purchase, running to at least several hundred dollars.
It is widely regarded as the authority on the certification of water filtration devices. Health Canada works in cooperation with each of these agencies. The NSF has six standards related to the certification of drinking water devices. Some are related to health effects, such as removing bacteria, THMs, and lead from water, while others address aesthetic effects, such as improving taste, odour and colour. Some are specific to the type of treatment system. The six ANSI (American National Standards Institute) and NSF standards are as follows:

- ANSI/NSF 42: Drinking Water Treatment Units — Aesthetic Effects
- ANSI/NSF 44: Cation Exchange Water Softeners
- ANSI/NSF 53: Drinking Water Treatment Units — Health Effects
- ANSI/NSF 55: Ultraviolet Microbiological Water Treatment Systems
- ANSI/NSF 58: Reverse Osmosis Drinking Water Treatment Systems
- ANSI/NSF 62: Drinking Water Distillation Systems

Read the labels carefully and look for reference to the specific standards. But it isn’t enough for the product to simply state that it has been “Tested to NSF Standards.” This only means that reference was made to the standards, not that the product was tested by NSF directly. For this claim to be made it must say “NSF Certified.” A system that has been certified by NSF is subject to unannounced inspections of its manufacturing facilities. This ensures that standards are maintained after the original NSF testing.

When buying a water filtration device, look for the actual certification mark of the NSF, CSA or UL as shown on the opposite page. Be forewarned, however: even this may not be enough. According to a Health Canada survey conducted in 1999, 4% of the systems they studied bore the NSF name or logo without actually being certified by NSF International. To be certain that the system you are considering is actually certified, contact the NSF for their complete list of certified water filtration products. For a copy of the list, contact them directly or access the list online at [http://www.nsf.org/certified/dwtu/listings.asp](http://www.nsf.org/certified/dwtu/listings.asp).

Bottled Water

Although bottled water has been available in the marketplace for many years, it wasn’t until the 1970s that it started to become popular in North America. At that time, specific regulations on pre-packaged water and ice were established in the Food and Drug Regulations (Division 12). An image began to develop of bottled water as a status symbol, a lifestyle choice, a matter of convenience in our fast paced “disposable” world. Soon, due to increasing health consciousness, people began to drink bottled water as a portable beverage of choice over soft drinks, juice, beer and coffee.

Then, when people first began to be concerned about the safety of their tap water, they turned to bottled water for health reasons. More recently, however, increasing health hazards and incidents related to the safety of tap water have fuelled similar concerns regarding the safety of bottled water.

The bottled water industry is estimated to be growing at a rate of 20% each year. Europe is, by far, the single largest market for bottled water with total consumption estimated at 27.6 billion litres per year. The US follows in distant second place, with an estimated total consumption of 11 billion litres. Asia is the third largest market and is expected to grow due to its high population growth. Latin America places fourth in consumption and Canada sits in fifth position. In 1995 Canadians are reported to have spent $292 million on bottled water. In 1997 the annual consumption was estimated to be 643 million litres, or 21.2 litres per person.
In Canada, bottled water is considered a food and thus falls under the responsibility of Health Canada and is regulated under the federal Food and Drug Act and Regulations (Division 12). These regulations define mineral and spring waters, are legally enforceable throughout Canada, and include microbiological quality standards, good manufacturing practices and labelling requirements. The Regulations limit the addition of fluoride and allow the use of the food additive carbon dioxide to produce carbonated water and ozone to prevent bacterial growth.

Many bottled water products sold in Canada are taken from aquifers. Some of these products are represented as spring or mineral waters if they are potable at the source, as required in the Regulations. Provincial ministries charged with the environment are responsible for approving permits for the extraction of water from underground sources. There may or may not be provincial limits governing the quality of bottled water.

The Food Directorate of the Health Products and Food Branch (HPFB) and the Canadian Food Inspection Agency (CFIA) are in the process of reassessing the existing regulations for pre-packaged water and ice, under Division 12 of the Food and Drug Regulations. The objective of the reassessment is to ensure that consumers are adequately protected and to update product labelling, taking into account the development of provincial, national, and international standards for these products. Proposed amendments will include detailed requirements regarding maximum limits for specific chemical, radiological and microbiological contaminants for pre-packaged water and ice. In setting these limits, the maximum allowable concentrations (MACs) prescribed under the Guidelines for Canadian Drinking Water Quality will be considered, when feasible. A consultation document on the proposals is being prepared to invite comments from the public and other stakeholders, before the drafting of final proposed amendments.

While the regulations define particularly spring and mineral water, there are several different types of bottled water offered for sale in Canada. The Canadian Bottled Water Association has adopted the following descriptions of five types of bottled water to guide its members in properly naming their product:

**Spring water.** According to the current federal food regulations, spring water is potable water that comes from any underground source but not from a public community water supply. The spring water collected and bottled is considered natural water and must have all the same properties and be of the same composition and quality as the water underground. Normally, spring water is expected to contain fewer than 500 parts per million (ppm) of total dissolved solids (minerals).

**Mineral water.** Mineral water follows the same definition as spring water except that it is normally expected to contain more than 500 ppm of dissolved solids.

**Purified water.** Purified water (defined only in US, but not in Canadian, regulations) is bottled water that has been produced by distillation, deionisation or reverse osmosis. The water can come from a spring or a public community water supply. Other suitable terms for bottled water produced by one of the above processes include “distilled water,” “deoxygenated water,” and “reverse osmosis water.” These waters have no added minerals.

**Carbonated bottled water.** Carbonated bottled water is bottled water that contains natural or added carbonation. Soda water, seltzer water and tonic water are considered soft drinks, not bottled waters.

**Drinking water.** Similar to purified water, drinking water is defined as bottled water that has been produced by distillation, deionisation or reverse osmosis. The water can come from a spring or a public community water supply. What differentiates drinking water from purified water is that drinking water may contain added minerals.
The importance of having access to good quality drinking water is abundantly clear. You might be wondering what government body in Canada is charged with this important task. We know about Health Canada, Environment Canada and Agriculture Canada. But since drinking water involves all of these jurisdictions, and more, who is ultimately responsible? The answer is, no one agency.

As is true for so many other issues in Canada, the jurisdiction and power of the various levels of government responsible for drinking water are divided and often confusing. At the federal level, the government is responsible for the quality of water on federal lands, and for providing scientific advice regarding contaminants in drinking water.
Federal and provincial/territorial governments share responsibility for the Guidelines for Canadian Drinking Water Quality. Health Canada is the technical secretariat to the Federal/Provincial/Territorial Subcommittee on drinking water, which is the entity responsible for development of the guidelines. In this role, Health Canada provides technical expertise and scientific advice regarding health-based drinking water guidelines. The provinces and territories use these guidelines as a basis for establishing their own guidelines, objectives, standards or regulations.

The provincial and territorial and municipal governments are responsible for drinking water quality, including ensuring that municipal treatment plants produce safe drinking water, and for protecting the quality of source water. They are responsible for establishing enforceable standards, objectives, guidelines or regulations as they relate to drinking water protection. Although their roles vary from province to province, municipal governments are generally responsible for owning and operating water supply systems and for providing safe, clean water to their citizens. Many municipalities, particularly larger ones, go beyond merely meeting the regulations as dictated by the province or territory. Municipal governments are generally responsible for owning and operating water supply systems and for providing safe, clean water to their citizens. Many municipalities, particularly larger ones, go beyond merely meeting the regulations as dictated by the province or territory. Municipal governments are generally responsible for establishing enforceable standards, objectives, guidelines or regulations as they relate to drinking water protection.

The Guidelines for Canadian Drinking Water Quality are intended to help provincial/territorial and municipal governments, as well as homeowners with private water supplies, to provide drinking water that is clean and safe enough to protect human health over a lifetime of consumption. The guidelines apply both to drinking water supplies that are public (e.g., municipally owned) and those that are private (e.g., wells on private property).

The Guidelines for Canadian Drinking Water Quality are just that — guidelines. They are not in any way binding to the provinces and territories. The provinces and territories generally use these guidelines as a basis for their own enforceable standards or regulations, or as guidelines. The Federal-Provincial Subcommittee on Drinking Water, made up of representatives from Health Canada, Environment Canada and each province and territory, is responsible for preparing the guidelines. As new information becomes available on the health impacts of drinking water contaminants and treatment technologies, the guidelines are updated to reflect increased understanding and to improve water quality.

The guidelines list recommended limits for the presence of substances and the conditions known to affect drinking water quality. Guidelines have been developed for substances that have been detected in water supplies across Canada and that are known or suspected to be harmful. For each listed substance, a limit on the maximum amount of the contaminant that may be present in the water is established. This amount is referred to as the “maximum allowable concentration” or MAC. The MAC is set according to scientific research findings in Canada and internationally.

A MAC value for a chemical is typically set from 10 to 5000 times lower than the lowest level at which adverse health effects have been observed in humans or other animals during long-term or repeated exposure to the substance. The MAC is set at this lower level with the objective of protecting all Canadians, regardless of age, physiological makeup and condition, and lifestyle. It also allows for uncertainties in the available data. In some instances, the MAC is established to protect the most sensitive subgroup of the population (e.g., the lead guideline was based on the effects on children).

Another reason for setting the MAC value significantly lower than that considered potentially harmful to human health is to take into account the possibility that people may be exposed to the substance from sources other than drinking water, such as food, air and soil.

In some cases there may not be enough scientific data available for the committee to use in setting a MAC with certainty. In such instances the committee will set a temporary, or interim, MAC (IMAC). IMACs are also established in cases where analytical methods or treatment technology methods are inadequate (i.e., if the health assessment indicates that the guideline should be lower, but the treatment or analytical methods cannot meet the lowered guideline, an IMAC is established). MACs must be achievable by readily available analytical or treatment technology methods.

Another reason for setting the MAC value significantly lower than that considered potentially harmful to human health is to take into account the possibility that people may be exposed to the substance from sources other than drinking water, such as food, air and soil.

In some cases there may not be enough scientific data available for the committee to use in setting a MAC with certainty. In such instances the committee will set a temporary, or interim, MAC (IMAC). IMACs are also established in cases where analytical methods or treatment technology methods are inadequate (i.e., if the health assessment indicates that the guideline should be lower, but the treatment or analytical methods cannot meet the lowered guideline, an IMAC is established). MACs must be achievable by readily available analytical or treatment technology methods.

In addition to MACs set for harmful substances, there are guidelines that refer to radionuclides in water. These guidelines list MACs for more than 80 natural and artificial radioactive contaminants. The sixth edition of the guidelines lists MACs for more than 80 microbial, chemical and physical contaminants, and 78 natural and artificial radioactive contaminants.


For questions on local water concerns contact your local public utilities commission, water utility or municipal public health department.
Drinking Water Materials Safety Act

Another responsibility of the federal government is to ensure that any materials with which drinking water comes into contact do not pose threats to human health. At present there is no legally enforceable legislation in Canada that addresses this issue. To fill this gap, in December 1996 the Minister of Health introduced the Drinking Water Materials Safety Act (Bill C-14) into the House of Commons. Unfortunately, the bill wasn’t passed. If it had been, it would have ensured that all materials coming into contact with drinking water, including treatment devices, treatment additives and treatment and distribution system components would have to be certified to designated standards before they could be sold in Canada.

Scientific researchers at Health Canada have reported both good news and bad news about the current safety of drinking water materials. The good news is that 70% of drinking water treatment additives sold in Canada already meet the standards proposed by Health Canada. The bad news is that 70% of drinking water treatment devices and 70% of drinking water system components do not meet Health Canada’s suggested standards.

Drinking Water Safety Program for Native People

In Canada, the incidence of disease as a result of water contamination is considerably higher in First Nations communities than in the general population. This is in part due to the fact that the water treatment facilities in many of these communities are either inadequate or non-existent. A survey by Health Canada found that there were health and safety concerns associated with almost 20% of the community water systems they tested.

To address these concerns, in 1991 the Medical Services Branch of Health Canada established the Drinking Water Safety Program for Native People. The program aims to help First Nations communities identify and address potential water quality problems.

Health Canada is working with the Assembly of First Nations to:
• increase sampling and analysis of drinking water for chemical contaminants;
• establish community-based water quality laboratories so that First Nations communities can monitor the bacteriological quality of their drinking water supplies;
• develop a training program for water treatment plant operators in these communities;
• offer advice on the design, operation and maintenance of water treatment facilities; and,
• advise on the importance of having a clean water supply, and the relationships between personal hygiene, drinking water quality and communicable diseases.

Provincial/Territorial Jurisdiction

Providing safe drinking water to Canadians is primarily the responsibility of the provinces and territories, although the federal government, specifically Health Canada and Environment Canada, also plays an important role. Environment Canada’s role includes responsibilities for protecting source water quality in trans-boundary water bodies such as the Great Lakes. There are significant differences in the ways that each region approaches drinking water protection. Specifically, there are variances in water quality testing, including the regulation of laboratories that perform the testing; water treatment; water delivery systems; and reporting requirements. Most provinces are currently revising, updating or putting regulations in place regarding drinking water.

Water Quality Testing

The federal government participates in developing the Guidelines for Canadian Drinking Water Quality. Each province and territory set its own standards and testing requirements for drinking water.

A recent report by the Sierra Legal Defense Fund, Waterproof: Canada’s Drinking Water Report Card (January 2001), describes the different types of legislative protection that may be offered for drinking water:

Drinking water protections may be created through laws (enacted by the provincial legislature), regulations (generally created by an agency or the provincial cabinet and approved by the provincial cabinet), permit or approval requirements, and guidelines (sometimes called objectives or protocols, which are created by an agency). There are important distinctions between laws, regulations, permit standards and guidelines. Laws, regulations and permit standards may create legally binding and enforceable standards and requirements, meaning that if your water provider is not meeting the relevant standards, enforcement action can be taken. Guidelines, on the other hand, are not generally binding. If your province or territory has established guidelines only, your water provider does not have to meet those guidelines.

As might be expected, the provinces and territories vary widely with respect to their regulations pertaining to drinking water. Some have enacted laws and regulations and permit standards, while others have guidelines only, your water provider does not have to meet those guidelines. If your province or territory has established guidelines only, your water provider does not have to meet those guidelines.

Table 1 on the following page summarizes the findings of the Sierra Legal Defense Fund as to whether provinces and territories have laws, regulations, permit standards or guidelines for drinking water. It is of greatest interest to note that, as of early 2001, there were four provinces that did not require mandatory testing for drinking water. One notable variance is the testing and sampling requirements of drinking water set out by each jurisdiction. Even within a particular province or territory there may be variances in testing requirements. Specifically, a particular municipality may have standards that are higher or lower than standards provincially or territorially imposed because of special permit or approval requirements. In addition, systems that distribute water to populations below a certain size may be exempt from the region’s testing standards. As might be expected, the provinces and territories vary widely with respect to their regulations pertaining to drinking water. Some have enacted laws and regulations...
sampling of any of these three types of parameters: Alberta, Newfoundland, New Brunswick and Prince Edward Island. While Alberta and New Brunswick may impose sampling requirements on a discretionary basis, New-Brunswick and Prince Edward Island did not impose sampling requirements on either a mandatory or discretionary basis. As noted elsewhere, however, regulations as they pertain to drinking water are changing very quickly. Check with your provincial ministry responsible for drinking water for the most up-to-date information.

Table I:
Mandatory Testing of Drinking Water According to Various Parameters

<table>
<thead>
<tr>
<th>PROVINCE/TERRITORY</th>
<th>Microbiological</th>
<th>Physical</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>British Columbia</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Manitoba</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Newfoundland</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Northwest Territories</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Nunavut</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Ontario (pre-Walkerton)</td>
<td>NO *</td>
<td>NO *</td>
<td>NO *</td>
</tr>
<tr>
<td>Ontario (post-Walkerton)</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Quebec</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Yukon Territory</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>


*Note: Ontario Ministry of the Environment staff note that mandatory testing for these parameters is done on a site-specific basis.

The Canadian results may be compared with legislation in the US where testing for more than 80 microbiological, chemical and radiological parameters is required. Beginning in 2003, the European Union will require testing for more than 45 parameters (microbiological, chemical and radiological). In all cases, testing frequency is determined by population size. [Note: Ontario Ministry of the Environment staff have commented that sampling frequency in Ontario is not population dependent.]

There is also variation among the provinces and territories as to whether water testing must be done at accredited laboratories (summarized in Table II). Laboratories that are certified or accredited help to ensure that accurate testing results are produced. Accredited labs have trained staff and proper equipment, and use appropriate testing. Labs may be accredited through government or private sector programs.

In January 2001 report, the Sierra Legal Defense Fund found that only five jurisdictions required the use of accredited labs: British Columbia, New Brunswick, Ontario (effective early 2001), Quebec and the Yukon. Six others made efforts to ensure accuracy by testing drinking water samples at provincial labs. Only one, the Northwest Territories, did not require either certified or selected water testing labs.

Table II:
Regulation of Testing Laboratories

<table>
<thead>
<tr>
<th>PROVINCE/TERRITORY</th>
<th>Accredited</th>
<th>ACCREDITATION OF TESTING LABS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta</td>
<td>NO</td>
<td>Microbiological testing is done at provincial labs; other testing is done at labs approved by the Director</td>
</tr>
<tr>
<td>British Columbia</td>
<td>YES</td>
<td>Testing is done at labs selected by the province</td>
</tr>
<tr>
<td>Manitoba</td>
<td>NO</td>
<td>Testing is done at provincial labs (but little testing is required)</td>
</tr>
<tr>
<td>Newfoundland</td>
<td>NO</td>
<td>Testing is done at labs acceptable to the Department of Environment</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>YES</td>
<td>Testing is done by territorial labs</td>
</tr>
<tr>
<td>Northwest Territories</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>Nunavut</td>
<td>NO</td>
<td></td>
</tr>
</tbody>
</table>

*Note: Ontario Ministry of the Environment staff note that mandatory testing for these parameters is done on a site-specific basis.
Table II: Regulation of Testing Laboratories, cont’d

<table>
<thead>
<tr>
<th>PROVINCE/TERRITORY</th>
<th>Accredited</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario (pre-Walkerton)</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>Ontario (post-Walkerton)</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>Quebec</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>NO</td>
<td>Testing is done at provincial labs or at labs selected by the province</td>
</tr>
<tr>
<td>Yukon Territory</td>
<td>YES</td>
<td></td>
</tr>
</tbody>
</table>


Water Treatment

Effective water treatment is needed to ensure that water is clean and safe for people to drink. However, whether treatment is required and what methods are used to treat water vary significantly from one province to another. Provinces and territories may approach the regulation of water treatment in one of two ways. One, the province or territory may require water providers to treat water using specific methods (disinfection, filtration, etc.). Alternatively, they may set regulations that specify certain standards of water quality (such as adherence to the Guidelines for Canadian Drinking Water Quality), but leave it up to the water provider as to how to meet those standards.

Researchers for the Sierra Legal Defense Fund reported that, as of January 2001, most provinces and territories required disinfection, but only two, Alberta and Ontario, also required filtration for surface water. (Since that time Quebec has also come to require filtration of surface water). More puzzling was the number of regions that didn’t require treatment of any kind. Once again, given the speed at which regulations are changing, it is advisable to contact the ministry responsible for drinking water in your province to learn what is required where you live. The Sierra Legal Defense Fund findings are summarized in Table III on the following page.

Table III:

<table>
<thead>
<tr>
<th>PROVINCE/TERRITORY</th>
<th>Disinfection</th>
<th>WATER TREATMENT REQUIREMENTS</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta</td>
<td>YES</td>
<td>Disinfection for groundwater and surface water, plus filtration for surface water</td>
<td></td>
</tr>
<tr>
<td>British Columbia</td>
<td>YES</td>
<td>Chlorination or other approved disinfection</td>
<td></td>
</tr>
<tr>
<td>Manitoba</td>
<td>YES</td>
<td>Chlorination</td>
<td></td>
</tr>
<tr>
<td>Newfoundland</td>
<td>NO</td>
<td>No mandatory treatment</td>
<td></td>
</tr>
<tr>
<td>New Brunswick</td>
<td>NO</td>
<td>No mandatory treatment</td>
<td></td>
</tr>
<tr>
<td>Northwest Territories</td>
<td>YES</td>
<td>Chlorination</td>
<td></td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>YES</td>
<td>Chlorination</td>
<td></td>
</tr>
<tr>
<td>Nunavut</td>
<td>YES</td>
<td>Chlorination</td>
<td></td>
</tr>
<tr>
<td>Ontario (pre-Walkerton)</td>
<td>NO</td>
<td>No mandatory treatment</td>
<td></td>
</tr>
<tr>
<td>Ontario (post-Walkerton)</td>
<td>YES</td>
<td>Chlorination for groundwater and surface water, plus filtration for surface water **</td>
<td></td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>NO</td>
<td>No mandatory treatment</td>
<td></td>
</tr>
<tr>
<td>Quebec †</td>
<td>YES</td>
<td>Disinfection with chlorine or other approved disinfection method for ground- and surface water, plus filtration for surface water (or groundwater subject to the influence of surface water)</td>
<td></td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>YES</td>
<td>Chlorination</td>
<td></td>
</tr>
<tr>
<td>Yukon Territory</td>
<td>NO</td>
<td>No mandatory treatment</td>
<td></td>
</tr>
</tbody>
</table>


† This is more recent information than appears in the Waterproof report.
*Note: The Ontario Ministry of the Environment had a policy for minimum treatment that was enforced when issuing Certificates of Approval. Source: Personal communication with staff of the Ontario Ministry of the Environment.
**Note: Chlorination for groundwater and surface water, plus chemically-assisted filtration for surface water and groundwater under the influence of surface water. Clarifications provided to Pollution Probe by the staff of the Ontario Ministry of the Environment.
Chapter Seven:  

Water Pricing and Conservation

Given that water is absolutely vital to our health and well being — indeed, to our very survival — it is astounding to think of how little we pay for it in Canada relative to other countries. The NUS Consulting Group (formerly the National Utility Service (NUS)) publishes a survey every year of international water costs. The NUS reports that, of all the countries it surveys, Canada charges the least for the treated municipal water it supplies to consumers.
In Canada we pay roughly $0.60 (Canadian) for 1,000 litres of water. Imagine 1,000 one-litre bottles filled with tap water — for all that water we pay only $0.60. Another way of looking at it is that, in Canada, with one single penny we can buy 16.5 litres of water.

In many jurisdictions Canadians pay a flat rate for their water, regardless of how much they use. A full ten million Canadians do not have metering of their water use. This means that people who are careful with their consumption and try to conserve as much as possible pay the same amount for the water they use as those who are wasteful and may use two, three or even four times as much. Of course, this is also the case in many other countries. Studies have shown that Canadian per capita consumption of water is 40% lower in areas where consumers are required to pay for the volume of water they actually use rather than a flat rate.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Cost (US$)/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Germany</td>
<td>1.689</td>
</tr>
<tr>
<td>2</td>
<td>Denmark</td>
<td>1.499</td>
</tr>
<tr>
<td>3</td>
<td>Belgium</td>
<td>1.165</td>
</tr>
<tr>
<td>4</td>
<td>United Kingdom</td>
<td>1.121</td>
</tr>
<tr>
<td>5</td>
<td>The Netherlands</td>
<td>1.112</td>
</tr>
<tr>
<td>6</td>
<td>France</td>
<td>1.041</td>
</tr>
<tr>
<td>7</td>
<td>Italy</td>
<td>0.688</td>
</tr>
<tr>
<td>8</td>
<td>Spain</td>
<td>0.595</td>
</tr>
<tr>
<td>9</td>
<td>United States</td>
<td>0.910</td>
</tr>
<tr>
<td>10</td>
<td>Australia</td>
<td>0.492</td>
</tr>
<tr>
<td>11</td>
<td>South Africa</td>
<td>0.485</td>
</tr>
<tr>
<td>12</td>
<td>Canada</td>
<td>0.369</td>
</tr>
<tr>
<td>13</td>
<td>Finland</td>
<td>0.361</td>
</tr>
<tr>
<td>13</td>
<td>Sweden</td>
<td>0.361</td>
</tr>
</tbody>
</table>


The survey is based on prices as of July 1, 2000 for a supply pipe/meter size of 50 mm (2 inch) for an organization with a annual usage of 10,000 cubic meters. All prices are in US dollars per cubic meter and exclude applicable taxes. Where there is more than a single supplier, an unweighted average of available prices was used. The percentage change figures shown are calculated using the local currency in order to eliminate currency movement distortion.

<table>
<thead>
<tr>
<th>Beverage</th>
<th>Cost ($/1000 litres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap water</td>
<td>0.60</td>
</tr>
<tr>
<td>Cola</td>
<td>850.00</td>
</tr>
<tr>
<td>Milk</td>
<td>985.00</td>
</tr>
<tr>
<td>Bottled water</td>
<td>1,500.00</td>
</tr>
<tr>
<td>Beer</td>
<td>2,500.00</td>
</tr>
<tr>
<td>Wine</td>
<td>9,000.00</td>
</tr>
<tr>
<td>Liquor</td>
<td>26,700.00</td>
</tr>
</tbody>
</table>

All amounts are in 2001 Canadian dollars.
Figure 9: Average Daily Domestic Water Use (per capita)


The average Canadian household uses more than 500,000 litres of water per year. That’s an average of 340 litres each day for each person in Canada. At least half of this amount is unnecessary and wasteful. Common causes of wasted water at home include leaking faucets, faulty plumbing, and the over-use of water for watering lawns and washing cars.

Figure 10: Where Water is Used Inside the Home


It is actually quite easy to cut back on the amount of water we use if we follow the 3Rs of water conservation: reduce, repair and retrofit. Here are some tips from Environment Canada based on the publication Water Conservation — Every Drop Counts from the Freshwater Series. (For more detailed information on repairs and retrofitting, request a copy of this publication by calling Environment Canada or visiting their Web site at http://www.ec.gc.ca/water/en/info/pubs/e_pubs.htm.)
**First R: Reduce**

Much of the water we use in our daily activities is simply wasted. We leave taps running while we brush our teeth. We run dishwashers without full loads. We take long showers and full baths. Just about everywhere we use water there are ways to conserve. Here are some suggestions:

- **Avoid flushing the toilet unnecessarily and don’t use it as a wastebasket.**
- **Take quick showers instead of running a full tub for a bath.**
- **Keep a bottle of drinking water in the fridge rather than letting your tap run to get cold water when you want a drink.**
- **More than 50% of water applied to lawns and gardens is lost due to evaporation and runoff because of overwatering.** To avoid this, water outdoors only as much as necessary and do it in the early morning, after the dew has dried and before the heat of the day begins.
- **When washing your car, fill a bucket with water and use a sponge.** This one change alone can save about 300 litres of water. Even better is to take your car to a car wash rather than washing it in the street. A single drop of oil going into a storm drain pollutes more than 10,000 litres of water.
- **Install water systems that direct water that has run through the washing machine to the toilet so that it is used again before being flushed away.**

**Second R: Repair**

Leaks can be very costly. A leak of only one drop of water per second wastes about 10,000 litres of water per year. Most leaks are easy to fix and repair costs are minimal.

- **Leaking faucets are often caused by a worn-out washer that costs pennies to replace. Ask at your local hardware store for a faucet repair kit and instructions.**
- **A toilet that continues to run after flushing can waste up to 200,000 litres of water a year. To find out if your tank is leaking, put a few drops of food colouring in the toilet tank. Wait a few minutes. If the colour shows up in the bowl, there’s a leak.**
- **Toilet leaks are often attributable to a few common, and easily repaired, problems.** If you’re a do-it-yourself type, consult a book or a friend for how to make repairs to the valve seat. Otherwise, call a professional for help.

**Third R: Retrofit**

Retrofit refers to adapting or replacing an older water-using fixture or appliance with a newer, more water-efficient device. While new devices often cost more, they can save water and money in the long run. Toilet retrofits can reduce water use by 70%. Low-flow showerheads can reduce water use by half, and low-flow aerators for faucets can cut consumption by 85%.

You can also retrofit the tools you use outdoors to water lawns and gardens. Sprinklers that lay water down in a flat pattern are better than oscillating sprinklers, which lose as much as 50% of what they disperse through evaporation. Drop irrigation systems, which apply water only to the root zone, are the most efficient (and expensive) option. And consider that the water you use on your lawn and garden doesn’t have to come out of a tap. A rain barrel can be used to collect rainwater for later use in irrigation.

Finally, consider a low-maintenance landscape — one that doesn’t require much more water than nature provides. Consult your local gardening or environmental store for information on ways to create a low-maintenance landscape, including reducing the lawn area, planting native plants, trees, and grasses, mulching to reduce water loss, improving the health of the soil, and installing a proper irrigation system.

Many municipalities have significant programs in place to encourage residents to reduce water use. Consult with your local municipality or public utility to find out what programs exist in your area.
By now it should be clear how much we are mistaken in Canada to take for granted the clean water that flows from our taps whenever we want it. The world’s freshwater supplies are very limited, and we are lucky to live in a region of the world so plentiful in fresh water and where supplies are made easily accessible to us. We are also fortunate to live in a country that has or can access the knowledge and resources to make sure that the water we drink is clean and safe.

We also know that, while the amount of water in the world has remained constant, conditions in the world are not constant. The world population continues to increase, and more and more people need to share this precious, limited water resource with one another and all the other creatures on the planet. If it keeps growing at its current pace, the human population is expected to double by 2050.
Another significant change taking place in the world that may greatly affect water supplies is global climate change. Increasing global temperatures are predicted to result in increased precipitation in some areas and increased evaporation in others.

In Canada it has been suggested that increases in water temperature will almost certainly change the numbers and types of bacteria and algae that will live in our lakes. It is not known how this will impact on water quality. It is possible that more frequent and more severe outbreaks of *Giardia* and *Cryptosporidium* could result due to changing microbiological and parasitic populations. It is also plausible that we may experience more taste and odour problems due to overgrowth of algae in warmer waters. Many of us may have recent memories of foul tasting water as a result of algal blooms during the summer months. Already these are occurring with increasing frequency, and we can probably expect more in the future.

In some areas it is predicted that water levels will become lower as a result of reduced precipitation and increased evaporation. This might require, for example, deepening intake pipes in such areas as the Great Lakes to avoid problems with shallow water. Lowered water levels are predicted to have an even greater impact on inland river and inland lake water supplies.

While it remains impossible to know exactly what will happen with respect to global climate change, it is possible to do something about it now. We clearly cannot control certain aspects of the hydrological cycle such as rainfall, but we can plan ahead for cycles of drought by making sure we get every available drop of rain into the ground so that it can be released when the system is short on resources. Simple things, like planting trees and protecting wetlands, are things we can do now to help ensure that we have clean and available water supplies into the future.
For More Information

Concerns around drinking water are increasing rapidly across Canada. Government drinking water policies and legislation are undergoing rapid change and it is essential for Canadians to keep up-to-date on these changes. The following information sources and Web sites should be consulted for more detailed explanations of specific issues than could be provided in this primer as well as for current information.
**Federal Agencies**

**Health Canada**

Headquarters
A.L. 0900C2
Ottawa, ON K1A 0K9
Phone: 613-957-2991
Fax: 613-941-5366
Web site: www.hc-sc.gc.ca

**Environment Canada**

National Water Issues Branch
Ecosystems and Environmental Resources Directorate
Conservation Service
351 St. Joseph Blvd., 4 PVM
Hull, PQ K1A 0H3
Phone: 819-953-6161
Fax: 819-944-0237
Web site: www.ec.gc.ca/water/e_main.html

**Provincial/Territorial Water Testing Facilities**

**Alberta**

Alberta Environment
920 – 108th Street, Main Floor
Edmonton, AB T5E 2B8
Phone: 780-944-0313
Fax: 780-427-4407
Web site: www3.gov.ab.ca/env/water.html

**British Columbia**

Ministry of Health Services
Drinking Water Program
P.O. Box 9050, Station Prov Govt
Victoria, BC V8W 9E2
Phone: 250-952-3456
Fax: 250-952-1883
Web site: www.hlth.gov.bc.ca/protect/water.html

**Manitoba**

Manitoba Conservation
200 Saulteaux Cres.
P.O. Box 44
Winnipeg, MB R3J 3W3
Phone: 800-214-6497
Fax: 204-945-7419

**New Brunswick**

Department of Environment and Local Government
P.O. Box 6000
Fredericton, NB E3B 0H1
Phone: 506-453-3700
Fax: 506-453-3843
Web site: www.gnb.ca/elg-egl/0009/0001/0009-e.html

**Newfoundland**

Department of Environment
Water Resources Division
P.O. Box 8700
St. John’s, NF A1B 4J6
Phone: 709-729-2563
Fax: 709-729-0320
Web site: www.gov.nl.ca/env/water_resources.asp

**Nova Scotia**

Department of Environment and Labour
5151 Terminal Rd.
P.O. Box 697
Halifax, NS B3J 2T8
Phone: 902-424-5300
Fax: 902-424-0503
Web site: www.gov.ns.ca/entm/rmep/h2o.html

**Ontario**

Ministry of the Environment and Energy
135 St. Clair Ave. West
Main Floor
Toronto, ON M4V 1P5
Phone: 416-325-4000
Fax: 416-325-3159
Web site: www.ene.gov.on.ca

**Prince Edward Island**

Environment and Land
11 Kent St.
P.O. Box 2000
Charlottetown, PE C1A 7N8
Phone: 866-368-5044
Fax: 902-368-5830

**Quebec**

Ministry of the Environment
Edifice Marie-Guyart, rez-de-chaussée
675, boulevard René-Lévesque Est
Québec, PQ G1R 5V7
Phone: 819-953-1616
Fax: 418-646-5974

**Non-governmental Organizations**

**American Water Works Association**

6666 West Quincy Avenue
Denver, CO 80235 USA
Phone: 303-794-7711
Fax: 303-795-1999
Web site: www.awwa.org

**Canadian Bottled Water Association**

155 East Beaver Creek Road
Unit 24, Suite 328
Richmond Hill, ON L4B 2N1
Phone: 905-886-6928
Fax: 905-886-9531
Web site: www.cbwa-bottledwater.org

**Canadian Water and Wastewater Association**

Blue Thumb Project
5330 Canotek Road, Suite 20,
2nd Floor, Ottawa, ON K1J 9C3
Phone: 613-747-0524
Fax: 613-747-0523
Web site: www.cwwa.ca

**Environmental Defense Canada**

2 College Street
Suite 208
Toronto, ON M5G 1K3
Phone: 416-323-9521
Fax: 416-323-9301
Web site: www.edcanada.org

**Pollution Probe**

625 Church Street
Suite 402
Toronto, ON M4Y 2G1
Phone: 416-926-1907
Fax: 416-926-1601
Web site: www.pollutionprobe.org

**Sierra Legal Defense Fund**

Vancouver Head Office
214-131 Water Street
Vancouver, BC V6B 4M3
Phone: 800-926-7744
Fax: 604-685-7813
Web site: www.sierralegal.org

**Selected References**


